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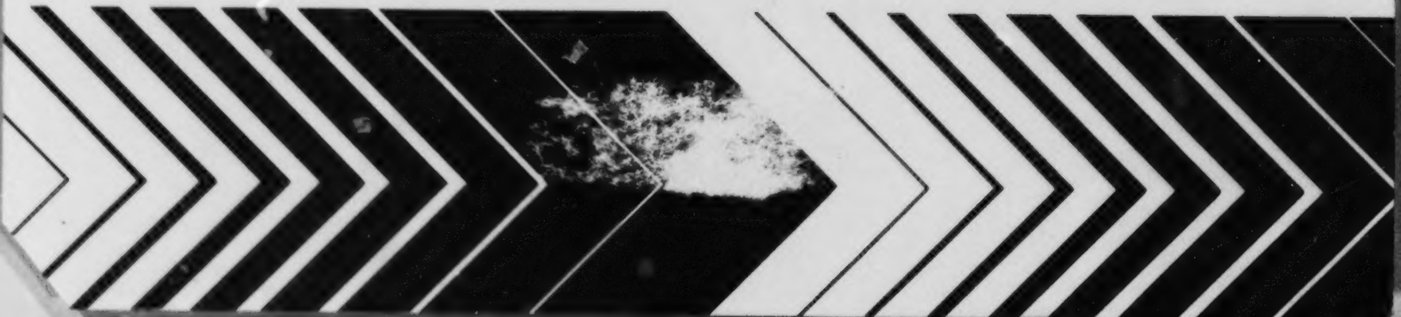

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16. ABSTRACT

This study investigates the relationship between cadmium, lead, zinc and mercury burdens and age in five different autopsy tissues. Approximately 30 autopsy cases in each of five age groups were studied. Autopsy cases were from sudden or accidental death victims living in the same metropolitan area (Dallas, Texas). Histories were collected on all cases to ascertain that a "non-exposed" population - with regards to cadmium - was sampled. Information on cigarette smoking, diseases, etc. was also collected. A concurrent epidemiological study was conducted in the Dallas metropolitan area to investigate the cadmium concentrations in urine and feces of persons (six age groups) not exposed to cadmium.

Atomic absorption spectrophotometry (AAS) was used for all metal measurements. The analytical methodology used for cadmium in eight different types of biological samples was evaluated in a round robin study involving laboratories in Japan and Sweden. Tissue preparation was with "low temperature ashing" techniques and both flame and flameless AAS were used. Analytical methodologies for cadmium analysis were investigated.

Statistical evaluation of the data was performed. Interrelationships between all autopsy tissues for each metal were examined. Total body burdens of cadmium were calculated for "standard man".

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THE DISTRIBUTION OF CADMIUM AND OTHER METALS IN HUMAN TISSUE

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FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory participates in the development and revision of air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is primarily responsible for providing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

Due to the severe neurologic and renal effects of cadmium observed in Japan and its presence in cigarettes and wastewater sludges, increased attention has been focused on this pollutant. Since little was known about typical levels of cadmium in the tissues of americans not occupationally exposed to cadmium, an epidemiologic study was designed and conducted to provide an estimate of those levels as well as an estimate of the daily intake of cadmium. This report presents the results of that study.

F. G. Hueter, Ph. D.
Acting Director,
Health Effects Research Laboratory

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I. INTRODUCTION

A. General Information

The health effects of exposure to cadmium have received considerable attention over the past several years. Cadmium has been shown for many years to be highly toxic to man(1, 2). The risk from occupational exposure to cadmium emissions has been documented and studied for several years(3, 4). These efforts have included the development of methodology to monitor and laws to regulate the maximum exposure to cadmium. The effects of exposure of cadmium in the general population have received considerable attention because of the occurrence of Itai-Itai disease and the high prevalence of proteinuria in areas of Japan with high exposures to cadmium(5, 6). Cadmium has also been suggested as a cause of cardio-vascular diseases and hypertension(7, 8). Acute exposure to relatively high levels of cadmium in air can produce a lethal pneumonitis whereas chronic exposure to lower air levels may produce primarily emphysema and proteinuria(6). The acute exposure to this metal via food causes vomitting, diarrhea and abdominal pain(9). The production of tubular proteinuria in man has been shown to occur following long term daily cadmium levels in food of the order of 200 to 300 μg/day(6). Estimates of daily dietary intake of cadmium in the United States have been reported to range between 20 and 130 μg(10, 11).

It has been reported that the body burden of humans for cadmium increases with age from virtually none at birth to about 30 mg in the fifth decade of life(12). It has also been reported that only approximately 5 per cent of the cadmium taken orally is absorbed, while up to 50 per cent may be absorbed when inhaled. Tobacco smoking contributes some additional quantities of cadmium via the respiratory route. Cadmium tends to accumulate in renal tissue and to lesser extent in liver. It has been proposed that measurement of cadmium in these two tissues should provide a useful indicator of total cadmium exposure and accumulation during life. This apparently is valid so long as renal and hepatic diseases are excluded and correction for age is considered(13-17). Measurement for cadmium in urine and blood provides a useful indicator of recent exposure to cadmium. Measurement of cadmium in feces provides a useful indication of the quantities of cadmium consumed daily since, as mentioned above, only about 5 per cent of the oral dose is absorbed with the remaining 95 per cent carried through in the feces. An excellent review of the health effects and biological involvement of cadmium can be found in the book by Friberg, Piscator, and Nordberg entitled, Cadmium in the Environment(6). This book documents the available data as of 1971 on cadmium regarding its analysis, metabolism, tissue distribution and toxicity.

B. Role of this Project in Cadmium Knowledge

At a meeting held in Hawaii in 1971 between Japanese and United States scientists, cadmium health effects research was discussed. Because a Swedish research group was at that time reviewing the health effects of cadmium under a contract from the Environmental Protection Agency, the concept of a three-country cooperative study on cadmium was initiated. A detailed protocol for this cooperative study was designed at a subsequent meeting in Tokyo in 1972. The effort in this report is a part of this cooperative study between research institutes in Japan, Sweden, and the USA (EPA and SwRI). When the study was planned, little valid data on the daily intake of cadmium were available. However, it was known that the industrial usage of cadmium in the United States had doubled every decade since the beginning of this century. It is also known that very little cadmium is recycled, which indicates a high percentage of it is probably lost to the environment. The participation of this laboratory in the cooperative study involved:

1. the validation of analytical methods for measurement of cadmium in a variety of biological matrices
2. estimation of body burdens based on measurements of liver, kidney cortex, pancreas, muscle, and fat from autopsy specimens of cases of sudden and accidental death
3. examinations of the relationships between daily intake and urinary cadmium by measurement of cadmium in feces and urine of study participants.

Studies involving autopsy tissue from accidental deaths are much more meaningful than those involving autopsy cases of deaths from natural cases. The latter approach suffers from bias since it generally results in an older population being studied. The incidence of disease among those individuals is higher, also, and there is frequently the involvement of medication. As a result, this group could not be considered as representative of the general population as the cases from accidental causes.

This study was designed to examine the relationship between cadmium body burdens and age in five tissues collected at autopsy and in the same metropolitan area living subjects with similar age, sex, and socioeconomic characteristics were to be examined for cadmium in urine and feces samples. The study was to include an estimate of individual variability. The autopsy samples were to be collected following sudden or accidential death of individuals living in a single metropolitan area with no known point sources of cadmium. The living participants were to be recruited from those

individuals without occupational exposure to cadmium. The study as mentioned above also includes an examination of the methodologies used in a collaborative test program involving both Japan and Sweden. The results presented here will form a portion of the collaborative study to be reported elsewhere.

II. METHODS

A. Analytical Methods Development

1. Cadmium Methodology

There are a number of atomic absorption spectrophotometric (AAS) procedures in the literature for determining Cd and other metals in biological tissues. Although some of these methods have attempted to determine the metal directly in the tissue--without any pretreatment--the more successful procedures rely upon some type of pretreatment to release the metals from the tissue matrix. This preparation usually consists of either wet or dry ashing of the sample matrix followed by solubilization. The resulting solution is homogeneous with respect to the analyte metals.

Both wet and dry ashing have advantages but a relatively new technique has been examined for preparing the various tissues examined in this study for trace metal analyses. This technique is low temperature ashing using an excited O_2 plasma under reduced pressure to oxidize the biological matrices to a powdered ash containing the analytical metals of interest. The most advantageous feature of low temperature ashing is the fact that during the ashing process the temperature of the sample never gets above 200°C; this very effectively prevents losses of the more volatile metals (Cd) associated with other wet and dry ashing procedures.

Because this low temperature ashing technique is relatively new, several other studies were made to determine how it compared with the more conventional wet ashing techniques used in preparing biological tissues for trace metal analyses.

Another technique of AAS has become very popular in recent years and that is the "flameless" mode of analysis using an electrically heated graphite furnace. Some work has been done with determining Cd and other metals in biological matrices using this flameless AAS technique. It appears to be the method of choice for particular tissues (e.g. muscle) where the trace metal concentrations are extremely low.

2. Instrumentation

All analyses were performed on either a Perkin-Elmer model 503 Atomic Absorption Spectrophotometer (AAS) or a Perkin-Elmer model 306 AAS. The Model 306 AAS is modified (Perkin-Elmer modification kit No. 040-0286) to reduce "stray light" from reaching the photomultiplier tube during operation of the flameless sampling devices.

Both AAS units are equipped with a Deuterium-arc background corrector which corrects for non-specific absorption. The background corrector was routinely used on all analyses. There was no difference in analytical data produced on either of these instruments.

Absorption peaks were recorded on a Perkin-Elmer Model 056 Recorder with a 10mv range.

Flameless analyses were performed with the following graphite tube furnaces: (1) a Perkin-Elmer HGA-2100 with the Model 503 AAS, (2) a Perkin-Elmer HGA-2000 with the Model 306 AAS, and (3) an Instrumentation Laboratory IL-455 with the Model 306 AAS. Flame analyses on both AAS units were by air-acetylene flames using a single-slot, 10-cm Burner Head (Perkin-Elmer Model 303-0418).

A LFE Corp. (Waltham, Mass.) Model LTA-505 Low Temperature Asher was used to ash the tissue samples using an oxygen plasma under reduced pressure.

Calculation of analytical curves, regression analysis and concentrations were performed on a Hewlett-Packard Programmable Calculator Model 9810A.

A Virtis "45" Homogenizer (Fischer Scientific, Houston, Texas) with stainless steel blades was used to homogenize the tissue samples.

Mercury analyses were performed with a UV Monitor Model 1235 (Laboratory Data Control, River Beach, Florida).

3. Reagents

Nitric acid (65%) used for sample preservation and ash solubilization is of the highest purity (Suprapur TM, EM. Laboratories, Inc., Elmsford, N.Y.). All other acids used are analytical grade (J.T. Baker Co., Phillipsburg, N.J.) unless otherwise noted.

Metal standard solutions (1000 ppm) are from Fischer Scientific (Houston, Texas) and Ventron Corp. (San Leandro, Calif.).

Organic solvents decane and methyl isobutyl ketone (MIBK) are from Eastman Kodak (Rochester, N.Y.).

The chelating reagent, ammonium pyrrolidinedithiocarbamate (APDC) is from Aldrich Chemical Co. (Milwaukee, Wis.).

Triton X-100 surfactant is from J. T. Baker (Phillipsburg, New Jersey).

Other reagents or chemicals used in this study are all analytical grade.

4. Contamination Control

A major problem in trace metal analysis is contamination of glassware, reagents and samples with the metal(s) being analyzed. Minimizing this problem requires an extensive control program involving glassware cleaning, protection, and quality control measures.

Cleaning - all glassware and polyethylene containers that come in contact with samples or reagents are cleaned by the following procedure: Items are washed thoroughly with a laboratory detergent (Alconox, Inc., New York) in tap water. The clean glassware is rinsed with deionized water and placed in an acid vat containing HNO_3(1:1) and allowed to soak for 6 to 18 hours. Clean polyethylene containers are also placed in the acid vat but are removed after 4 to 6 hours. After acid soaking, the items are rinsed thoroughly with deionized water and placed in a drying oven until dry. The dry items are placed in a dust-free area and allowed to cool. Polyethylene containers are capped and sealed in polyethylene bags until ready for use. Glassware is returned to its proper container (see below) and stored in glassware cabinets until ready for use.

Protection - all glassware items are kept in polyethylene containers to minimize exposure to dust in the laboratory. Each container is numbered and contains one type of glassware (i. e. watchglasses, 5-ml volumetric flask, etc.). When all the glassware in a container has been used, it is returned to that container and carried through the washing procedure (see above) as a unit. While the glassware is being washed the container is also washed. Once the glassware has completed the wash cycle and dried, it is returned to the proper container. Several items (3 to 7) of glassware are removed from the container at this time for quality control checks.

Quality Control - the number of each container of glassware going through the wash cycle is entered into a log book. Other information, such as name of technician performing washing procedure, type of glassware, length of acid-soaking, etc., are also recorded in this log book. This allows the glassware removed for quality control checks to be identified with a particular set of glassware being used in the laboratory. The glassware removed for quality control purposes is checked by rinsing with a known volume of 0.1N HNO_3 and comparing with the same acid that has not been used for rinsing. Normally one metal (Cd) is used for quality control checks but other metals may also be included if needed. The graphite furnace (AAS) is used for quality control analysis. Glassware which shows a significant difference between the used and unused rinsing acids metal content is referred back to the container number from which it came. That container is then returned to the washroom and the wash cycle repeated on all its glassware.

5. Methodology Studies

Interferences from high salt concentration on Cd determinations by flame (air/acetylene) AAS have been reported in the literature for some biological samples.

To determine the effect of indigenous salt concentrations in each of the tissues upon their Cd determinations, a study was designed to compare the direct analysis of the ashed tissue solution with an extracted aliquot of those solutions. Seven samples from each tissue-type (except fat) were analyzed for Cd by the procedures detailed later. Also a 5-ml aliquot of the ashed tissue solution was extracted 1:1 with an APDC-MIBK extration procedure, which includes a pH adjustment to 7. Table 1 summarizes the results. The extracted Cd mean for each tissue is slightly less than the direct Cd mean. Applying a t-test to these means indicates there is no significant difference between them. Therefore, there is no interference on the Cd determinations by the natural concentration of salt in the tissues when analyzed by these procedures.

To determine if the low temperature ashing method would provide consistent results for a volatile element like Cd, an evaluation of the low temperature ashing procedures (described later) used for the preparation of the autopsy tissue samples was performed. Replicate, homogenized samples of each tissue type (except fat) were analyzed for Cd after being prepared by (1) the low temperature ashing procedures and (2) by wet-digestion in a closed Teflon bomb system using HNO_3 acid. The results are given in Table 2. For each tissue type the between-replicate variation is higher with the Teflon bomb digestion. Muscle, liver, and kidney by the Teflon bomb gave consistently lower Cd values than the low temperature ashing method. The results for pancreas tissue are the same using either method.

Since there is less between-replicate variation with the low temperature ashing procedure and fewer procedural steps involved, the low temperature ashing provides a more efficient system for preparing tissue samples for trace metal analysis.

TABLE 1 . CADMIUM: COMPARISON OF DIRECT vs EXTRACTED ANALYSIS OF TISSUE DIGEST SOLUTIONS

Tissue Type	MUSCLE		LIVER		KIDNEY		PANCREAS	
Analytical Method	Direct µg/g	Extract µg/g	Direct µg/g	Extract µg/g	Direct µg/g	Extract µg/g	Direct µg/g	Extract µg/g
Sample No. 1	0.033	0.013	0.667	0.779	7.49	7.03	0.612	0.630
2	0.018	0.035	0.836	0.651	7.32	6.64	0.700	0.709
3	0.011	0.019	0.812	0.601	7.63	6.40	0.568	0.709
4	0.014	0.036	0.836	0.644	6.85	6.71	0.612	0.552
5	0.030	0.017	0.657	0.619	6.67	7.27	0.656	0.630
6	0.039	0.014	0.661	0.691	7.19	6.67	0.568	0,512
7	0.035	0.029	0.757	0.850	7.32	6.91	0.656	0.473
Mean	0.026	0.023	0.747	0.691	7.21	6.81	0.625	0.602
Sd. Dev.	0.011	0.010	0.084	0.091	0.34	0.29	0.049	0.093
RSD (%)	44.1	43.5	11.2	13.2	4.8	4.2	7.8	15.5
t	0.3325		1.0560		1.9116		0.6065	
Significant level	0.75		0.33		0.11		0.57	
Significant at 0.05	No		No		No		No	

TABLE 2. CADMIUM: COMPARISON OF LOW TEMPERATURING ASHING WITH TEFLON BOMB DIGESTION OF TISSUES

Tissue Type	MUSCLE		LIVER		KIDNEY		PANCREAS	
Prep. Procedure	LTA Ashing	Teflon Bomb	LTA Ashing	Teflon Bomb	LTA Ashing	Teflon Bomb	LTA Ashing	Teflon Bomb
n	7	7	7	7	7	7	7	7
mean (µg/g)	0.026	0.016	0.747	0.619	7.21	5.51	0.625	0.627
st. dev. (µg/g)	0.011	0.020	0.084	0.102	0.34	0.36	0.049	0.066
RSD (%)	42.3	125	11.2	16.5	4.7	6.5	7.8	10.5
t	-1.1011		-2.4819		-9.0745		0.0730	
significance level	>0.10		~ 0.03		<0.01		>0.10	
significant at 0.05	No		Yes		Yes		No	

Of the five types of tissue examined in this project only the fat tissue resisted oxidation in the low temperature asher (LTA). After 48 hours, a 0.5 gram portion of fat tissue showed no signs of ashing with a forward power setting on the LTA of 450-500 watts (maximum).

Therefore, a study was made comparing an "open" digestion procedure with a "closed" Teflon bomb digestion to determine which method would be more suited to this project. The wet digestion procedure used is detailed later under Methodologies. The Teflon-bomb procedure consisted of weighing 0.5 gm of fat tissue into a Teflon-bomb and adding 5-ml of HNO_3 (Suprapur) and heating on a hot plate (100°C) for 2 hours. The digestate is filtered and the filtrate made up to 10-ml with 0.01N HNO_3. The results are summarized in Table 3. Two different fat samples were used in this study.

Even though the relative Cd concentrations for each tissue are significantly different, the precisions are relatively close. If one outlier (0.026) in the wet digestion is discarded, the CV for this procedure becomes 47.6% which is the same as the Teflon bomb procedure (47.8%). The Teflon bomb did not give a completely digested sample even after extensive digestion times (6 to 8 hours) and the use of $HClO_4$. The bomb digestion method was discarded in favor of the wet digestion procedure since the time required by either method was similar and the wet procedure gave a completely digested sample.

Another problem encountered with the fat tissue was the time required to obtain a homogeneous sample with the Virtis "45" homogenizer. Homogenization of the fat tissue required approximately 4 hours per sample. This time was not acceptable to meet contract completion dates and the stress placed on the homogenizer was too great (overheating and motor failure). To evaluate the amount of precision in the analytical data that would be lost by using non-homogenized fat tissues, a comparison study was performed using Cd as the analyte. Table 4 gives the results of this study. There is a significant difference between the homogenized and non-homogenized fat samples with respect to Cd.

6. Methodologies

a. Sample Preparation of Autopsy Tissues

Preparation of kidney, liver, muscle, and pancreas tissues followed the same basic procedure for all metals except Hg. The frozen tissue was allowed to thaw completely before a 5- to 15-gram portion was removed using stainless steel surgical scissors. The tissue was weighed directly into a Pyrex homogenization flask (10 to 50-ml) and an equivalent volume of metal-free water was added to aid the homogenization.

TABLE 3 . CADMIUM: COMPARISON OF TEFLON BOMB DIGEST vs WET DIGEST OF NON-HOMOGENIZED FAT TISSUE

	Teflon Bomb μg/g	Wet Digest μg/g
	0.085	0.009
	0.049	0.016
	0.027	0.017
	0.085	0.009
	0.152	0.008
	0.101	0.004
	0.130	0.026
mean	0.090	0.013
st. dev.	0.043	0.007
CV%	47.8%	53.8%

TABLE 4 . CADMIUM: COMPARISON OF HOMOGENIZED vs NON-HOMOGENIZED FAT TISSUE

	Homogenized µg/g	Non-Homogenized µg/g
Analysis No. 1	0.085	0.017
Analysis No. 2	0.049	0.058
Analysis No. 3	0.027	0.047
Analysis No. 4	0.085	0.096
Analysis No. 5	0.152	0.035
Analysis No. 6	0.101	0.005
Analysis No. 7	0.130	0.093
Mean	0.090	0.050
SD	0.043	0.035
RSD	47.78%	70.0%

Various homogenization times were required for each type of tissue. They range from 3 minutes for liver tissue to 4 hours for fat tissue. An aliquot of the homogenate (1 to 3 grams) was weighed into a tared Pyrex ashing-boat and placed in a vacuum oven at 75°C until the sample was completely dry. Then it was placed in a dessicator, allowed to cool, and weighed before being placed in the low temperature asher (LTA-505).

Each tissue type required different ashing times to completely ash the sample. The optimum ashing times for each tissue matrix were determined by ashing a series of tissue samples for specific time intervals until a constant ash weight was obtained and the ash had a uniform appearance. A safety time-factor was added to that time interval required for complete ashing. This became the ashing time used for that sample matrix. If sample weight or asher parameters were varied, then a new ashing time was determined by this procedure.

Ashing parameters were maintained at 35cc per minute O_2 and 400 to 500 watts forward power, depending upon the sample matrix being ashed. Periodic checks were made upon the low temperature ashers' performance by ashing a carbon rod of known weight and determining the weight loss after prescribed ashing time. The manufacturer's manual gives the weight losses necessary for correct operation of the asher unit.

Once the samples had ashed for the prescribed length of time, they were removed from the asher chamber and 1 ml of 65% HNO_3 (Suprapur) was added to dissolve the ash. The dissolved ash was quantitatively filtered through a pre-washed (0.01N HNO_3) glass-fiber filter (Reaves Angel, Whatman, Inc., Clifton, N.J.) and the filtrate collected in 10 ml volumetric flask. The sample was made to 10 mls with 0.01N HNO_3 and analyzed by AAS.

Fat samples were not homogenized. Approximately 1 gm of fat was removed from the bulk sample with stainless steel scissors and weighed directly into a 250 ml Vycor beaker. Twenty-five milliliters of 65% HNO_3 (Suprapur) were added and the sample was placed on a hot plate (90°C) and allowed to digest for approximately 3 to 4 hours just below the boiling point of the solution. The sample was placed on another hot plate (150°C) and the digestion continued while the volume was reduced by evaporation. When approximately 5 to 10 ml of sample remained, the beaker was removed from the hot plate and 5 ml of 70% $HClO_4$ (Suprapur) was carefully added. The sample was returned to the hotplate (150°C) and the digestion continued for 1 to 2 hours.

If a clear, amber-colored digest solution was not evident at this point, another 5 mls of $HClO_4$ was added and the digestion continued for another hour. If a clear, amber-colored solution did not result from this second addition of $HClO_4$, the sample was removed from the hot plate, allowed to cool, and 25 ml of HNO_3 added. The digestion procedure was then repeated.

After the sample was digested and had been evaporated to approximately 5 ml (never allowing sample to go to dryness) it was allowed to cool and quantitatively transferred to a 25 ml volumetric flask. Nitric acid (0.01N) was used to make the volume to 25 mls. At this point, the sample was ready for analysis by AAS.

Preparation of the autopsy tissues for Hg analysis started with the homogenized sample for all tissues except fat. Mercury determinations were made on non-homogenized fat samples.

A 1- to 4-g portion of the homogenized tissues or 1g of fat tissue was weighed into a 2.5-cm x 13.0-cm digestion tube with a 24/40 ground glass joint. Five mls of $HClO_4$: HNO_3 (5:1) were added followed by 1 ml of $KMnO_4$ (5%). The sample was mixed and placed in a water bath (75°C) for 20 minutes. Fat samples were left in the water bath for 2 hours.

Tissue samples, other than fat, were removed and allowed to cool before adding 10 ml of deionized water and 1 ml of hydroxylamine hydrochloride (50%). Fat samples were maintained at 75°C in the water bath while 10 ml of deionized water and 1 ml of hydroxylamine hydrochloride (50%) were added. The digestion tubes were swirled to mix the reagents. The samples (including fat) were ready for Hg determination by the cold vapor technique.

b. Sample Preparation of Live-Volunteer Samples

Feces samples were prepared for Cd analysis by digesting with H_2SO_4 - H_2O_2. A 5-g portion of the well-mixed feces sample was weighed into a 250-ml Pyrex beaker and 30-ml of H_2SO_4 added. The sample was digested for 15 to 20 minutes at room temperature (exothermic reaction) before 10 ml of H_2O_2 (30%) was added. After a few minutes, the feces was completely digested (clear solution).

The beaker was placed in an ice bath to cool for several minutes then the digest was quantitatively transferred to a 100-ml volumetric flask. Deionized water was used to bring the volume to 100 mls. The flask was cooled in an ice bath, and 10 mls of diluted digest was pipetted into a 20-ml screw cap centrifuge tube and 0.5 mls of 0.5M KI solution added. One milliliter of Amberlite LA-2 (Rohm & Haas, Inc., Philadelphia, Pa.) in decane (1%) was added and the sample was vigorously shaken for 30 seconds. The sample was centrifuged for 10 minutes at 2500 RPM and the organic solvent (top layer) removed to a small glass vial. Cadmium analysis was performed on this extract using flame (air-acetylene) AAS.

Urine samples acidified (1% v/v) with HNO_3 (analytical grade) at the time of collection were thoroughly mixed and a 10-ml aliquot removed for Cd analysis.

The 10-ml urine aliquot was placed in a 20-ml screw cap centrifuge tube and the pH adjusted to 7 with NH_4OH. One ml of 0.05M Trizma buffer (pH 7.0) (Sigma Chemical Co., St. Louis, Mo.) was added and the sample was mixed on a Vortex shaker for 1 minute. The Cd was chelated by adding 1 ml of a chelating solution consisting of 2% APDC in 2% Triton X-100. Next, 1 ml of MIBK (water saturated) was added and the sample was shaken vigorously for 1 minute, then centrifuged at 2500 RPM for 10 minutes. The MIBK solvent (top layer) containing the chelated Cd was removed and placed in a small glass vial. This extract was then ready for Cd analysis by flameless AAS.

c. Sample Analysis of Autopsy Tissue Samples

The prepared autopsy samples were analyzed for Cd, Pb, and Zn by flame AAS or flameless AAS. The cold-vapor AAS technique was used for all Hg determinations.

Table 5 gives the method of AAS analysis and the parameters for each metal-matrix combination.

Autopsy tissue samples were quantitated by analyzing aqueous spiked standards containing the same acid concentration as the diluted ash samples. An analytical curve was determined by least squares regression of peak height vs. concentration using a Hewlett-Packard Model 9810A programmable calculator. Figures 1 through 5 illustrate the analytical curves used to calculate the sample concentrations.

The calculator program allows the reagent blank to be automatically subtracted out and the peak heights and weights of the unknown samples (autopsy tissue and feces) entered so that the concentration of analyte metal will be expressed as μg/gram of wet weight.

Table 6 gives the sensitivity, limit of detection, precision, and recovery for each metal-matrix combination using each of the analytical techniques developed above.

TABLE 5 . ANALYTICAL PARAMETERS

Tissue	Parameters	Cadmium = 228.8nm	Lead = 283.3nm	Zinc = 213.9nm	Mercury = 253.7nm
Kidney	AAS Technique	flame	flameless	flame	cold-vapor
	Type of Sample	aqueous	aqueous	aqueous	aqueous
	Dilution Factor	none	none	6 & 11	none
Muscle	AAS Technique	flameless	flameless	flame	cold-vapor
	Type of Sample	aqueous	aqueous	aqueous	aqueous
	Dilution Factor	none	none	41	none
Liver	AAS Technique	flame	flameless	flame	cold-vapor
	Type of Sample	aqueous	aqueous	aqueous	aqueous
	Dilution Factor	none	none	21	none
Pancreas	AAS Technique	flame	flameless	flame	cold-vapor
	Type of Sample	aqueous	aqueous	aqueous	aqueous
	Dilution Factor	none	none	11	none
Fat	AAS Technique	flameless	flameless	flame	cold-vapor
	Type of Sample	aqueous	aqueous	aqueous	aqueous
	Dilution Factor	none	none	none	none
Feces	AAS Technique	flame			
	Type of Sample	extract			
	Dilution Factor	none			
Urine	AAS Technique	flameless			
	Type of Sample	extract			
	Dilution Factor	none			

FIGURE 1 . CADMIUM STANDARDS FOR MUSCLE TISSUE, HGA-2000 GRAPHITE FURNACE, PEAK HEIGHT vs CONCENTRATION

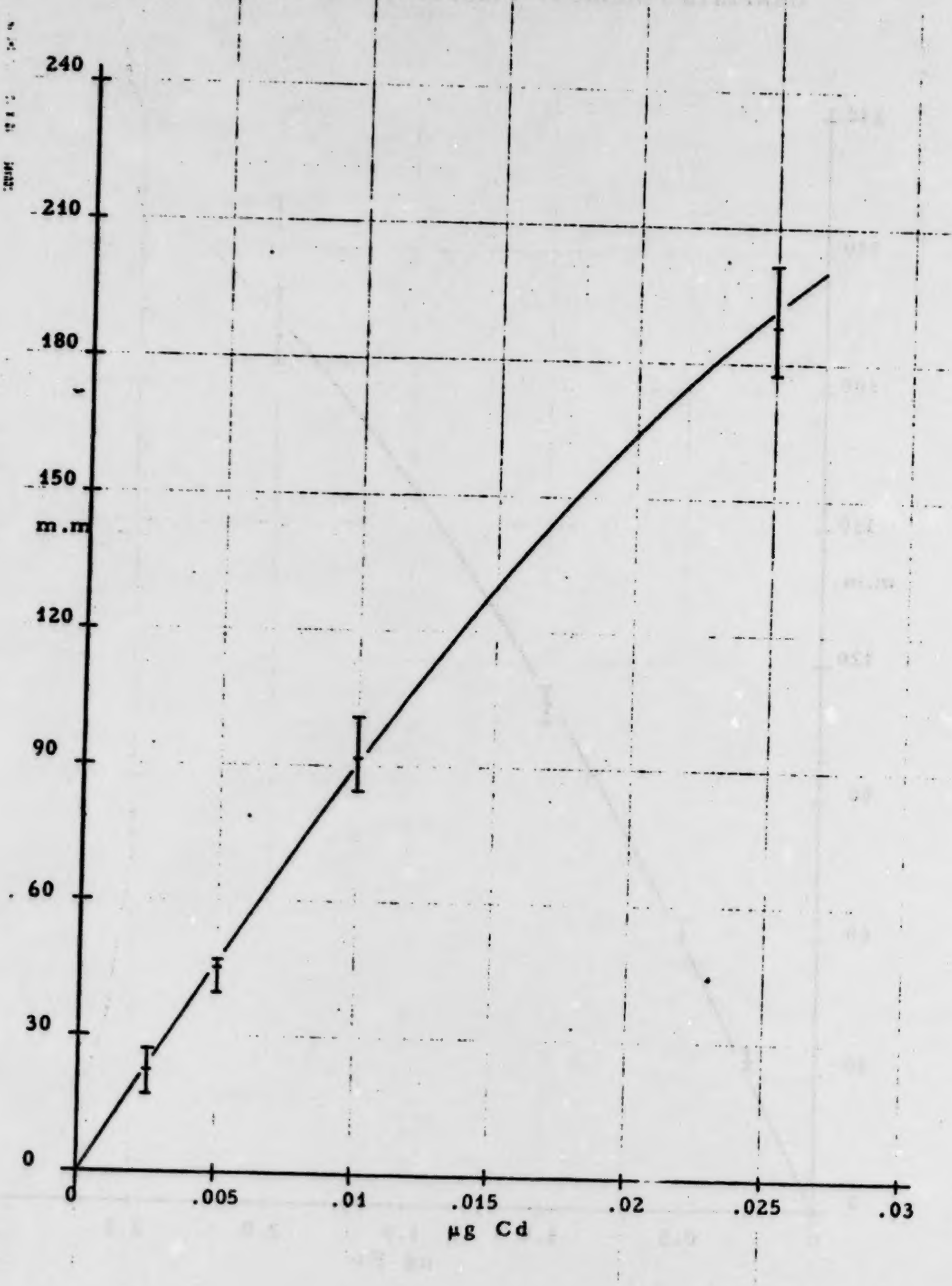


FIGURE 2 . LEAD STANDARDS FOR KIDNEY TISSUE. HGA-2000 GRAPHITE FURNACE. PEAK HEIGHT vs CONCENTRATION.

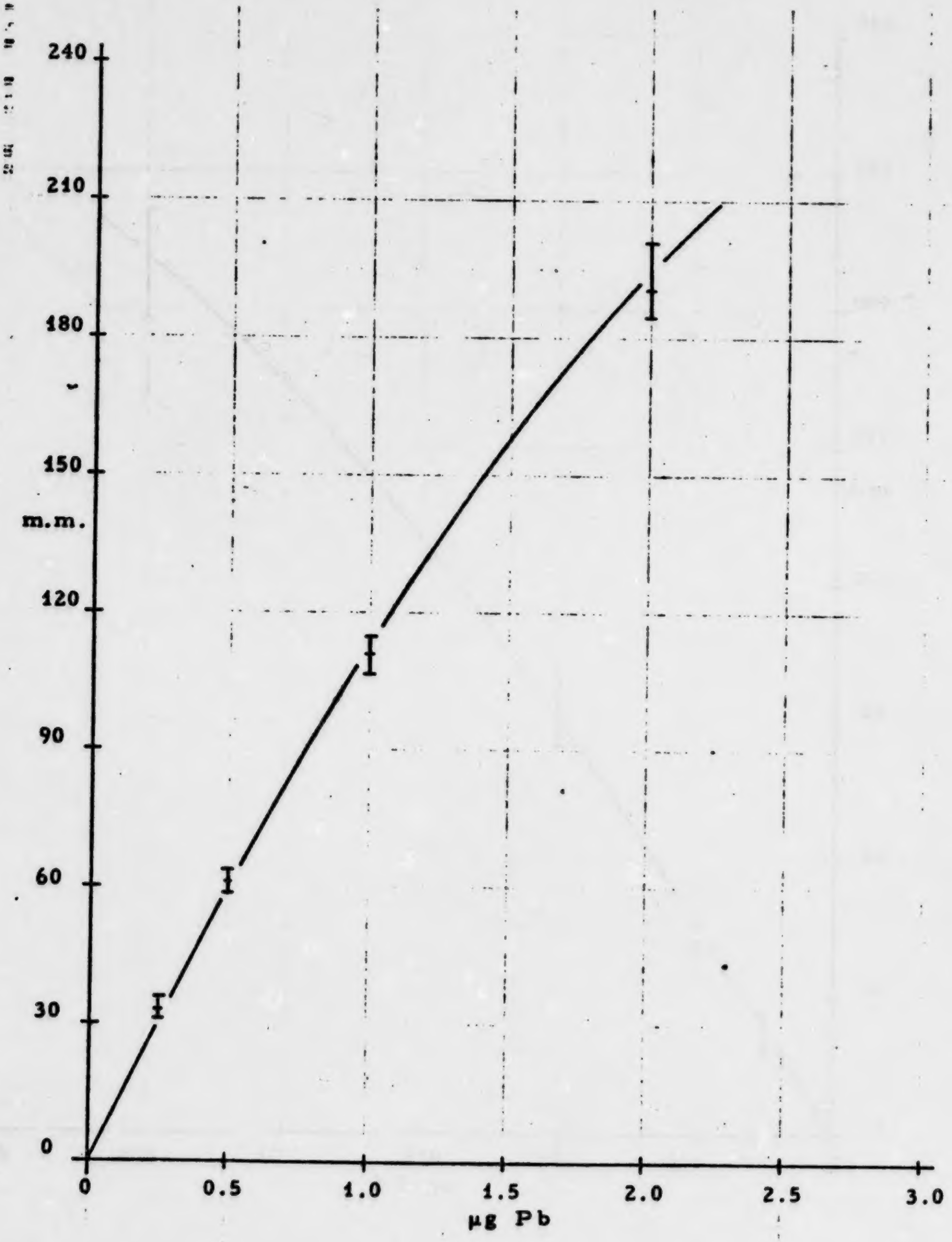


FIGURE 3 . CADMIUM STANDARDS FOR KIDNEY TISSUE. AIR-ACETYLENE FLAME. PEAK HEIGHT vs CONCENTRATION.

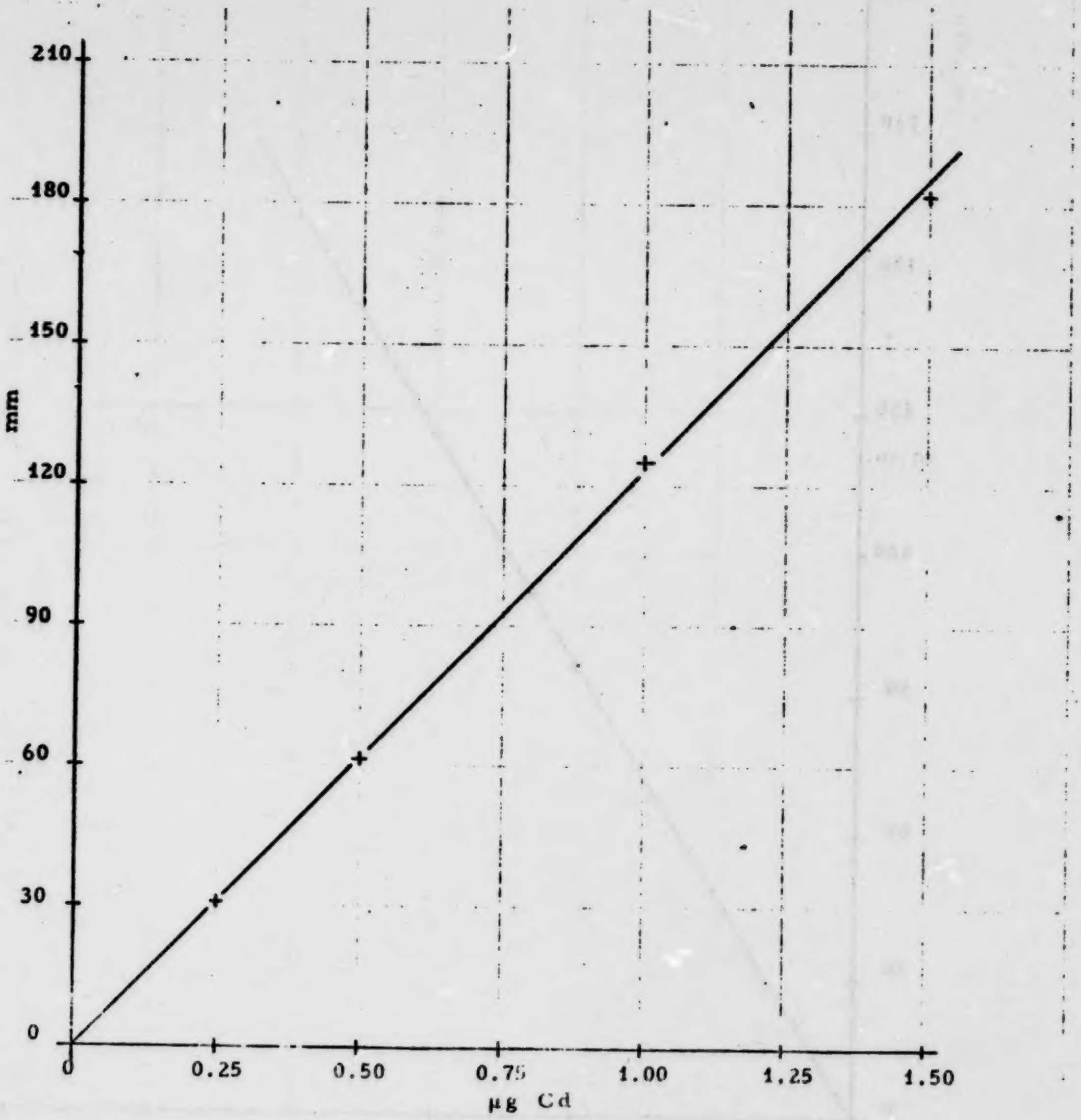


FIGURE 4 . ZINC STANDARDS FOR KIDNEY. AIR-ACETYLENE FLAME. PEAK HEIGHT vs CONCENTRATION.

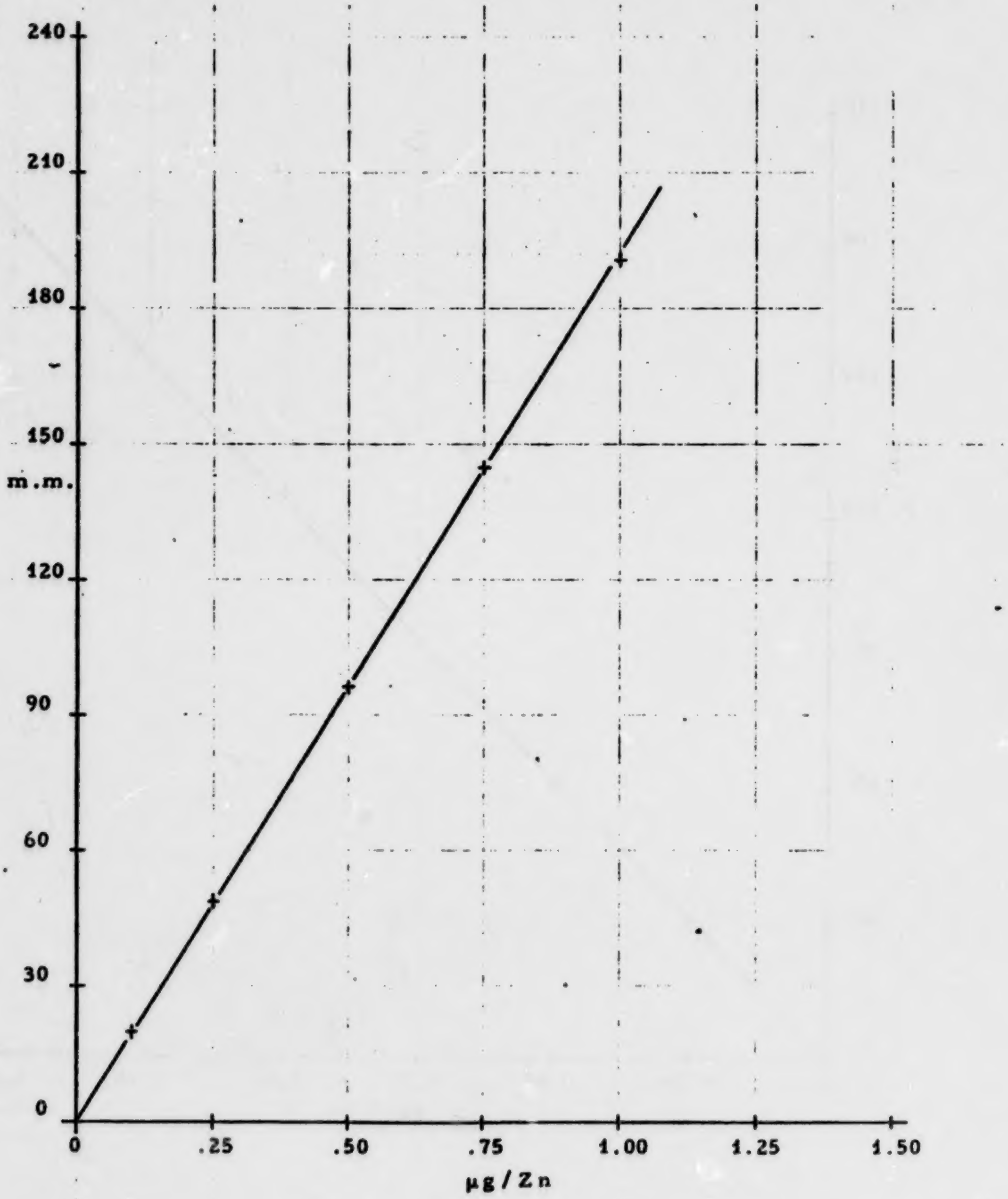


FIGURE 5 . MERCURY STANDARDS FOR KIDNEY TISSUE. COLD-VAPOR TECHNIQUE. PEAK HEIGHT vs CONCENTRATION.

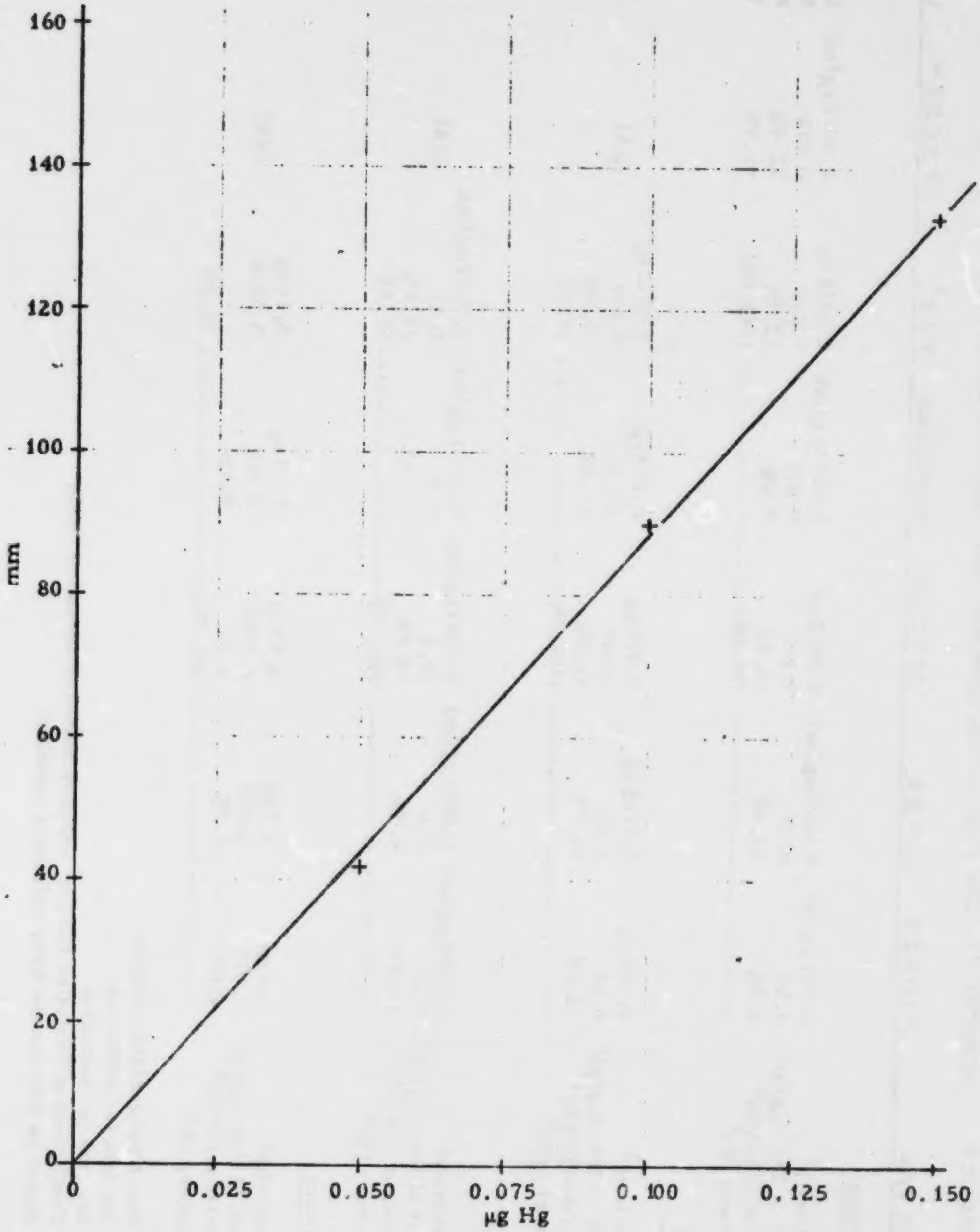


TABLE 6 . SENSITIVITY, LIMIT OF DETECTION AND PRECISION OF EACH METAL-MATRIX COMBINATION

Tissue Type	KIDNEY	LIVER	MUSCLE	PANCREAS	FAT[1]	FECES	URINE
Cadmium							
Sensitivity[2]	0.009 µg/ml	0.0029 µg/ml	0.0012 ng	0.0023 µg/ml	0.0037 ng	0.0019 µg/ml	0.08 pg
Limit of Det. (µg/g)[3]	0.50	0.13	0.013	0.071	0.015	0.014	0.13 µg/l
Precision (CV%)[4]	4.8%	11.2%	44.1%	7.8%	53.8%	12.4%	8.5%
Recovery (%)[5]	------	------	(95.6%)	------	(148.8%)	96.9%	99.7%
Lead							
Sensitivity[2]	0.020 ng	0.0062 ng	0.009 ng	0.017 ng	0.0042 ng		
Limit of Det. (µg/g)[3]	0.09	0.23	0.017	0.133	0.034	(NA)	(NA)
Precision (CV%)[4]	22.1%	24.9%	32.6%	21.4%	95.9%		
Recovery (%)[5]	------	------	(122.5%)	------	75.6%		
Zinc							
Sensitivity[2]	0.0058 µg/ml	0.0041 µg/ml	0.0063 µg/ml	0.0061 µg/ml	0.0022 µg/ml		
Limit of Det. (µg/g)[3]	9.2	3.3	18.6	5.5	0.51	(NA)	(NA)
Precision (CV%)[4]	13.0%	4.4%	15.8%	11.4%	22.6%		
Recovery (%)[5]	------	------	(92.0%)	------	95.5%		
Mercury							
Sensitivity[2]	1.2 ng	1.7 ng	0.17 ng	0.13 ng	0.11 ng		
Limit of Det. (µg/g)[3]	0.079	0.015	0.0002	0.001	0.0022	(NA)	(NA)
Precision (CV%)[4]	4.0%	6.7%	8.0%	5.6%			
Recovery (%)[5]	------	------	(83.3%)	------	75.2%		

(1) Non-homogenized samples
(2) See text for definition
(3) See text for definition
(4) Coefficient of Variation (CV) or Relative Standard Deviation (RSD)
(5) Based on NBS bovine liver reference standard

Sensitivity is defined as that concentration of analyte in the digest solution which will give an absorption of 0. 0044 absorbance units (1% absorption).

Limit of detection is defined as that concentration of analyte which will give an absorbance that is twice the standard deviation of a series of solutions the analyte concentration of which is distinctly detectable above the background absorbance.

Precision is based upon repetitive determinations of the analyte in a sample matrix using 4 to 10 samples.

Recoveries are based upon NBS bovine liver samples in all procedures except urine. For urine the recovery is based upon spiked samples.

d. Sample Analysis of Live-Volunteer Samples

Prepared excretia samples - feces and urine - were analyzed for Cd by flame and flameless AAS respectively.

Quantitation of feces extracts for Cd were done by extracting acid (1:1 H_2SO_4) standards using the same procedure given for extracting the feces. Analytical curves from these standards and calculations of Cd concentrations in the unknown samples were performed on the Hewlett-Packard Model 9810A as described above and the results expressed in μg/g wet weight.

Urine samples were measured by spiking urine samples with known amounts of Cd and extracting by the procedure given earlier. These spiked urines were used to calculate an analytical curve as described for the autopsy samples except no weight factor was used. The results are expressed in μg of Cd/liter of urine.

7. Quality Control

A major consideration of any analytical methodology involving a large number of analyses is the control of factors which decrease the accuracy and precision of the data generated. In trace metal determinations, where ppm and ppb quantities are being determined, control of these factors becomes critical and must be monitored continuously.

Autopsy tissues were monitored by analyzing spiked samples that had previously been calibrated against NBS bovine liver reference standard. Also, the duplicate analysis performed on each tissue sample served as a quality control.

A large, homogeneous, composite feces sample was prepared and routinely analyzed as a quality control for the feces samples.

The analytical procedure for Cd analysis of urine was not adequate for the NBS bovine liver. Therefore, spiked urine was used for quality controls rather than the NBS bovine liver. Six spiked urine quality controls were prepared and analyzed for each 30 urine samples analyzed.

B. International Cadmium Study Group's Round Robin

1. Purpose

A cooperative study between Sweden, Japan and the USA was organized to obtain baseline data on the body burdens, organ burdens, and daily intake/excretion of Cd in non-exposed populations of these countries.

Another area of concern to which the Study Group addressed itself was an evaluation of the methodologies used to produce the Cd data. This was accomplished by each participant analyzing a series of various sample matrices for Cd and comparing the results.

The final report of this three-year cooperative study is being prepared. Interlaboratory evaluations of the methodologies are available at this time and have been included in this report (Appendix D).

2. Samples

Samples from Sweden and from Japan were received in our laboratories for Cd analysis. Swedish samples were water (40), rice (10), wheat (5), flour (5), feces (6), urine (8), blood (8), and liver (10). Japanese samples consisted of kidney (10) and liver (10). All of these samples were received in our laboratory in excellent shape except for the urine. Even though the urine samples had been acidified prior to shipment, a fine, granular precipitate was observed in each of the eight samples received.

3. Procedures

The methods used to prepare and analyze the feces, liver, and urine samples were not the same as those used on the Dallas samples.

Following the October, 1976, meeting of the Study Group, another series of samples was distributed to the participants for Cd analysis. Our laboratory analyzed this second series of samples using the same methodologies that were used to prepare and analyze the Dallas samples (liver, feces, urine).

This second series of samples included six freeze-dried muscle tissue composites based upon six different age groups collected in Dallas. These samples were distributed to the laboratories in Sweden and Japan for Cd analysis. Our laboratory also performed Cd determinations on these samples. Urine samples (10) were also collected in our laboratory and aliquots sent to Sweden and Japan for Cd analysis.

The interlaboratory evaluation of this latest series of samples has not been reported at this time.

Procedures for the Cd analysis of the first series of Swedish samples and the results are given in Appendix E.

4. Results

The data from the interlaboratory Cd study (Appendix D) is summarized in Table 7. Included are the instrumental method each laboratory used, the type of samples analyzed, and the acceptability of the data. Laboratory number 6 is our laboratory designation. Only four of the 20 laboratories performed Cd analyses on all sample matrices. Cadmium analysis of the water samples were performed by all 20 laboratories. This sample matrix allows the accuracy of the final stages of analysis to be evaluated thereby eliminating this as a factor of variability in the biological samples.

Tables 8 and 9 illustrate how each laboratory performed in relation to each other on the interlaboratory Cd study. Our results on the low Cd-concentration biological samples are 29 per cent (urine) to 60 per cent (blood) lower than the other laboratories, while at the higher Cd-concentration of biological samples our values are 3 per cent higher (liver) to 55 per cent lower (blood) than the other 19 laboratories.

The low results for blood is thought to be caused by an inadequate digestion of the whole blood. Without complete digestion, the Cd would not be released from the protein components of the blood and therefore not be available for extraction. This procedure has proven adequate for Pb analysis of whole blood.

Table 7. Laboratories Participating in the International Collaborative Cadmium Study

Laboratory Identification	Method of Cadmium Analysis	Tissues Analyzed							
		Blood	Feces	Liver	Urine	Rice	Water	Wheat	Wheat Flour
1. LAB 1	Flame AAS	X	X	X	X	X	X	X	X
2. LAB 2	AAS			X	X	X	X	X	X
3. LAB 3			X			X	X	X	X
4. LAB 4	Extraction AAS				X	X	X	X	X
5. LAB 6 (SwRI)	AAS	X	X	X	X	X	X	X	X
6. LAB 7		X	X	X		X	X	X	X
7. LAB 9		X					X		
8. LAB 10 PPG	Pulse polarography	X			X		X		
9. LAB 10 AAS	AAS	X			X		X		
10. LAB 11							X		
11. LAB 12	Flameless AAS		X				X		
12. LAB 13		X	X	X	X	X	X	X	X
13. LAB 14		X			R		X		
14. LAB 15	Flame AAS	X					X		
15. LAB 17 WET	AAS - Wet			X			X		
16. LAB 17 DRY	AAS - Dry			X					
17. LAB 18		X	X	X	X	X	X	X	X
18. LAB 19							X		
19. LAB 20 FLAME	Flame AAS	X			X		X		
20. LAB 20 FLESS	Flameless AAS	X			X		X		
21. LAB 21		X			R		X		
22. LAB 22	Direct AAS	X			X		X		
23. LAB 22 EXTR	Extraction AAS						X		
Number of Accepted Laboratories		14	7	8	11	8	22	8	8

LEGEND:
X - Accepted Analysis Results
R - Rejected Analysis Results

Table 8. Laboratory Variation and Relative SwRI Agreement in International Collaborative Cadmium Study

Sample Medium	Number of Collab-orating Labs	Range of Cadmium Concentration Sample Means	Coefficients of Variation		Relative Agreement
			Between Laboratory C.V., % $\hat{\beta}_b$	Within Laboratory C.V., % $\hat{\beta}$	(SwRI-Other Labs), Other Labs
TISSUES					
Blood	14	µg/100ml			
		0.12 to 0.18	91%	42%	-60%
		0.26 to 0.36	52%	37%	-55%
Feces	7	µg/g			
		0.43 to 0.86	24%	21%	-8%
Liver	8	µg/g			
		1.3	26%	—	-32%
		3.0 to 9.9	11%	7%	+3%
Urine	11	µg/l			
		0.50 to 0.58	66%	32%	-29%
		0.66 to 0.79	26%	18%	+2%
FOODS					
Rice	8	µg/g			
		0.07 to 0.11	100%	22%	-62%
		0.12 to 0.18	54%	13%	-44%
		0.24 to 0.73	27%	—	-43%
Water	22	µg/l			
		3	160%	—	-69%
		6 to 15	44%	24%	+6%
		22 to 92	21%	15%	+2%
		105 to 165	14%	9%	-12%
		181 to 203	12%	7%	-4%
Wheat	8	µg/g			
		0.04 to 2.4	39%	11%	-58%
Wheat Flour	8	µg/g			
		0.02 to 0.06	42%	21%	+43%

Table 9. Laboratory Variation and Relative SwRI Agreement

By Sample Block

Sample Medium	Samples Comprising the Block	Range of Cadmium Concentration Sample Means	Coefficients of Variation		Relative Agreemen
			Between Laboratory C.V., % $\hat{\beta}_b$	Within Laboratory C.V., % $\hat{\beta}$	(SwRI-Other Labs) / Other Labs
TISSUES					
Blood		µg/100ml			
	A,C,E,F	0.12 to 0.18	91%	42%	-60%
	B,H	0.26	52%	33%	-56%
	D,G	0.34 to 0.36	52%	42%	-53%
Feces		µg/g			
	A,B,D	0.43 to 0.45	21%	18%	-15%
	E,F	0.50 to 0.55	28%	27%	+12%
	C	0.86	26%	—	-18%
Liver		µg/g			
	A	1.3	26%	—	-32%
	E	3.0	10%	—	-10%
	I	3.3	15%	—	-5%
	D,G,J	3.7 to 3.8	11%	5%	+8%
	C,H	5.1 to 5.5	14%	11%	+11%
	F	7.5	6%	—	+12%
	B	9.8	9%	—	-14%
Urine		µg/l			
	C,D,G,H	0.50 to 0.58	66%	32%	-29%
	A,B	0.66 to 0.67	25%	21%	-17%
	E,F	0.73 to 0.79	27%	15%	+25%
FOODS:					
Rice		µg/g			
	C,D,F	0.07 to 0.11	100%	22%	-62%
	E	0.12	44%	—	-37%
	B,H	0.15 to 0.16	56%	13%	-47%
	A	0.18	60%	—	-42%
	G	0.24	28%	—	-36%
	J	0.46	28%	—	-47%
	I	0.73	25%	—	-45%

Table 9. Laboratory Variation and Relative SwRI Agreement

By Sample Block (Continued)

Sample Medium	Samples Comprising the Block	Range of Cadmium Concentration Sample Means	Coefficients of Variation		Relative Agreemen
			Between Laboratory C.V., % $\hat{\beta}_b$	Within Laboratory C.V., % $\hat{\beta}$	(SwRI-Other Labs)/Other Labs
Water		μg/l			
	31	3	160%	--	-69%
	11	6	37%	--	+15%
	21,26	11	42%	15%	+23%
	1,2,32,36	13 to 15	47%	27%	-3%
	3,4	22	18%	8%	+9%
	12	27	26%	--	+7%
	22,27,33,37	30 to 34	27%	17%	+9%
	5	50	23%	--	+14%
	13	70	15%	--	-8%
	14,15,23,28,34, 38	82 to 92	18%	15%	-5%
	6,7	105	13%	8%	-11%
	16	114	13%	--	-25%
	17	127	14%	--	-9%
	8	138	15%	--	-7%
	18,19,24,29,39	148 to 157	14%	9%	-13%
	9,35	160 to 165	13%	10%	-11%
	10	181	12%	--	-13%
	20,25,30,40	196 to 203	12%	7%	-1%
Wheat		μg/g			
	D	0.04	44%	--	-56%
	C,E	0.07 to 0.08	35%	11%	-62%
	B	0.10	37%	--	-64%
	A	2.40	43%	--	-44%
Wheat Flour		μg/g			
	B	0.02	44%	--	+113%
	A	0.04	39%	--	+58%
	C,D,E	0.05 to 0.06	42%	21%	+21%

Low Cd values for the urine may be caused by the non-homogeneous urine samples received. Recovery values for spiked urine appear to be adequate (see Table 6) with the extraction procedure used on the Dallas samples which is similar to the one used here.

The samples originally sent from Sweden for this interlaboratory Cd evaluation were analyzed by procedures that were more expedient for a small number of samples. These procedures are different from those used on the large quantity of samples from Dallas. To eliminate this additional variable, another set of freeze-dried liver and feces samples from Sweden were analyzed in our laboratories using the procedures developed for this project.

It was also decided at the October, 1976, meeting of the International Cd Study Group that more collaborative analyses should be performed on urine and muscle samples. Ten urine samples were collected in our laboratory and acidified with 1% HNO_3 (Suprapur). Aliquots of these 10 samples were shipped to Sweden for Cd analysis. Also these samples were analyzed for Cd in our laboratory using the extraction procedure developed for the Dallas urine samples.

Muscle tissue composites from six different age groups (Dallas autopsy samples) were freeze-dried and each divided into four parts. Two of the muscle tissue sets (6 samples each) were retained in our laboratory for Cd analysis. One set of the muscle tissue samples were sent to Sweden and another set was sent to Japan.

Evaluation of these additional samples (feces, liver, urine and muscle tissue composites) has not been reported at this time.

C. Design of the Study

1. Components of the Study

The study was designed to obtain information on the body burden of Cd and on the daily intake of Cd from a population not exposed to a point-source of the metal. To accomplish this, samples were taken and information collected on two categories of subjects: autopsy cases and live volunteers.

As discussed earlier, the autopsy cases were selected to be victims of accidental death to minimize the bias which could be present if natural cause deaths were used. This bias would result if the disease process or medication taken for it would affect the trace metal pattern of the body. The subjects were to be selected to conform to a rigid set of selection criteria, including race, sex, and location of residence. This was done to minimize the variables which affect the concentration of Cd in the body.

To obtain corresponding data on daily intake and excretion, voluntary participants were recruited for the study. These individuals were matched as nearly as possible to the autopsy cases to allow comparison between the two sets of data.

2. Data Collected

Five tissues were sampled in the autopsy victims: kidney, liver, muscle, pancreas, and fat. Each of these tissues was to be analyzed in duplicate for Cd and for three other metals; Pb, Hg and Zn.

Clinical specimens were taken from the voluntary participants consisting of feces and urine samples. These were analyzed for Cd content to indicate the exposure levels to Cd and daily intake of the metal.

Two questionnaires were prepared for obtaining information on the subjects which could be useful in evaluating the results. The data to be collected included smoking history, current cigarette smoking habits, presence of air-conditioning in the home, occupation, medical history and diet. Friends or relatives of the autopsy cases were contacted to obtain the necessary information, to the extent possible, while the volunteer subjects were interviewed to obtain the information.

D. Selection of Study Location

1. Location Selected for Study

a. Selection Criteria

The study site selected for this study had to meet three principal criteria. First, the site required a sufficient population and a sufficient number of autopsies performed for traumatic injury deaths to support the study. Second, because the study was designed to provide a baseline for cadmium, zinc, lead, and mercury levels in a normal population, the area selected needed to be one with no outstanding levels of these metals in the general environment; further, the area selected should be free of industries known or expected to release significant amounts of these metals into their surroundings. Third, cooperation with the local medical examiner's office was required for any area selected. This is due to the dependence on that office for collection of the required autopsy samples and the delivery of those samples to the study team for analysis.

In selecting the study site, a fourth and obvious consideration was also accounted for: distance from San Antonio, Texas. This consideration was due to the location of the laboratories to which all samples must be shipped for analysis and at which the principal personnel involved in the study are based.

b. Selection of the Study Site

Of a number of areas considered to be potentially acceptable for study sites, two areas were selected as outstanding: San Antonio, and Dallas, Texas. Discussions with medical examiner's offices in each of these sites and data regarding the numbers of autopsies performed annually led the study team to conclude that Dallas, Texas would provide an optimum setting for the study. The Medical Examiner's Office, under the direction of Dr. Charles S. Petty, M.D., has responsibility for performing autopsies for sudden or accidental deaths for all of Dallas County. The county has a population in excess of one million persons and in 1973 more than 1300 autopsies of the type of interest to this study were performed by the Medical Examiner's office.

Dallas County is highly industrialized, with major industries in the fields of electronics, aircraft, merchandising, and banking. There is very little heavy industry such as steel, oil, and chemicals. As expected from analysis of the types of industry present, the resulting pollution levels are low for a major metropolitan center. This is particularly true of the background level for the metals of interest to this study. Contacts with the Medical Examiner's Office showed enthusiasm for the study proposed and a willingness to cooperate. The nearness of Dallas to the San Antonio laboratories and the frequency of airline connections between the two cities during the day and night provided the final ingredient for selection of that city as the study site. Dallas was selected and final arrangements for autopsy samples were begun with the Medical Examiner's Office.

E. Design of Autopsy Study

1. Specification of Target Population

The study specified samples of five tissues to be collected from 150 white males, with 30 cases in each of the decades of age 10 through 59. In addition to the tissue samples, information regarding cause of death, age, occupation, length of residence in the study area, smoking history, and incidence of certain diseases was to be collected for each case. The approach taken in this study was to arrange for the samples to be taken by the Medical Examiner's Office, packaged, stored, and transmitted to the San Antonio Laboratories for analysis when sufficient samples were in storage to make a reasonable package for shipment.

An information sheet was designed to collect the necessary background data for each case. Because of the sensitivity of these data, it was decided by the Medical Examiner's Office that collection of the background information would be accomplished by that office. It was decided that the best and most effective method for obtaining the background information would be telephone interviews with members of the family or friends of the deceased person.

2. Arrangements with the Medical Examiner's Office

After initial contacts with the Medical Examiner's Office to determine the feasibility of performing the proposed study, a staff member of the project team visited the Medical Examiner's Office to make final arrangements. In Dallas County, the Medical Examiner's Office is maintained at the Institute of Forensic Sciences, Parkland Memorial Hospital. Dr. Petty, Medical Examiner for Dallas County, assigned to Mrs. Mildred Odell the task of coordinating the planned study activities.

It was decided that the Medical Examiner's Office would be compensated for the time and effort spent in obtaining, packaging, labeling, and shipping the sample tissues. To this purpose, it was agreed that the Medical Examiner's Office would receive $10 for each case, and all other costs encountered, such as dry ice, packaging materials, and airline transportation costs, would be reimbursed.

For each investigation to determine the necessary background information on an autopsy case, the staff member performing the investigation would receive $15, paid directly to him. No formal contract was required to establish the relationship between the project team and the Medical Examiner's Office. The details of the agreement were formalized by a letter from the Project Director to the Medical Examiner.

3. Sample Collection, Storage, and Analysis

a. Collection

Procedures for collection of the autopsy samples were discussed with the Medical Examiner's staff. The basic approach was designed to minimize contamination of the tissue samples during collection and to ensure that sufficient quantities of each tissue specimen would be collected.

It was requested of the Medical Examiner's staff that a minimum of 25 grams of tissue be collected from the following anatomical areas of each case:

- Abdominal fat from the umbilical area
- Psoas muscle
- Right lobe of the liver
- Tail of the pancreas
- Cortex of the kidney

The Medical Examiner's staff was instructed about minimizing contamination of the sample during the collection process. The following guidelines were discussed:

- Avoid contaminating sample with other body fluids
- Avoid contaminating sample with extraneous material on body (dirt, oil, etc.)
- Use only stainless steel instruments
- Do not use sample known to be contaminated
- Do not rinse tissue sample with water
- Rinse gloved hands with deionized water when contaminated with other body fluids and prior to actually handling tissue sample
- Prefer to have assistant help - only one person actually handle tissue specimen though
- Place tissue into polyethylene bag directly from subject
- Have assistant immediately seal polyethylene bag once sample has been introduced into it
- Once sample is in bag, assistant should label it with autopsy number, tissue type, and date sample taken
- Sample should be placed into freezer within 30 minutes after removal from the body - the sooner the better.

b. Storage and Shipping

Discussions with the Medical Examiner's staff about storage precautions and shipping arrangements were made. The points covered in these discussions included:

- Maintain the samples in the frozen state
- Do not allow samples to become contaminated during shipment
- Prefer to have all tissues from one subject shipped in the same mailer - or at least at the same time
- Enough dry ice should be included in mailer to last for two days
- Styrofoam containers should be well sealed before shipment
- In each mailer there should be a list including: the number of tissue samples in that mailer, the total number of samples shipped at that time, the name of the subjects or autopsy number, and the type of tissues.
- Notify SwRI personnel when tissue samples are being shipped

Shipment by air freight was used for all the tissue samples and there were no problems encountered with those arrangements throughout the collection phase of the project.

c. Analysis

All tissues were analyzed by atomic absorption spectrophotometry for Cd, Pb, Zn and Hg.

The preparation procedures and the instrumental procedures used are given in the "Methods" section of this report.

4. Background Information

a. Requirements for Information

The study required samples of five specific types of tissues to be collected from autopsies of 150 white male persons from the study area. Desired for study purposes were autopsy samples from sudden or accidental deaths, excluding poison cases, with 30 cases in each of the following age ranges: 10 - 19; 20 - 29; 30 - 39; 40 - 49; 50 - 59. In each case, the name of the person was held in confidence by staff of the Medical Examiner's Office. To the project staff, the autopsy cases were identified only by a numerical code assigned routinely to each autopsy case performed.

To obtain the additional information required for each autopsy case, an information sheet was devised. The form of the information sheet is shown in Figure 6. The sheet provided the person working the case a list of the information items necessary to sufficiently identify the background of the person from whom the autopsy sample was taken. Verified on the form are cause of death, sex, race, length of residence, and occupation of the subject. These had to meet the study criteria or the case was rejected from further analysis. Age is recorded because a specific spectrum of ages was required for the study, and once the quota was met within a given age group, no further cases were developed for that group. Additional information items include further occupational and residence questions, smoking history, and incidence of certain chronic illnesses.

b. Information Collection Methods

Using the information sheets provided by the project team, a member of the Medical Examiner's Office telephoned the family of the deceased person within one month after the autopsy was performed. During a brief telephone conversation, the necessary background data were obtained. For some cases, more than one telephone call was required to obtain all the background data. The data obtained in this manner were recorded directly on the forms and the forms were transmitted to the San Antonio laboratories for analysis with the tissue samples collected. Each form was identified by the Dallas County Autopsy Number, and the name of the deceased person was held in confidence by the staff of the Medical Examiner's Office. The person who actually collected the background information was compensated at the rate of $15 per each complete and acceptable case.

5. Statistical Methods

The statistical analysis of the data generated on this program was designed to determine the pattern of the distribution of the metals under study in the body, to estimate the concentration in people of varying ages, to determine if differences exist which can be related to the smoking habits of the individual, and to investigate in a limited fashion the distributional nature of the determined concentrations for the population under study.

Figure 6.

SOUTHWEST RESEARCH INSTITUTE
Project 01-4005 Information Sheet

		Cols
Dallas County Autopsy Number ☐	☐☐☐☐☐☐	1-6
	4 0 0 5	7-10
Race 1 - White 2 - Non-White	☐	11
Sex 1 - Male 2 - Female	☐	12
Age ______	☐☐	13-14
Cause of Death ______	☐☐	15-16
Occupation ______	☐☐	17-18
Name of Employer ______		
Number of times changed jobs during past five years ______	☐	19
Number of children ______	☐	20
Length of residency at present address ______	☐☐	21-22
Length of residence in Dallas area ______	☐☐	23-24
Status of air-conditioning at present address: 0 - none, 1 - window unit, 2 - central	☐	25
Number of times changed place of residence during past five years ______	☐	26
Has deceased ever smoked as many as five packs of cigarettes, that is, as many as 100 cigarettes during his entire life? 1 - no 2 - yes	☐	27
Did deceased smoke regularly prior to his death? 1 - no 2 - yes	☐	28

Has deceased ever been diagnosed as having any one of the following chronic illnesses:

	1 - No	2 - Yes	Type		Cols
tuberculosis	______	______		☐	29
malignancies	______	______		☐	30
asthma-hay fever	______	______		☐	31
diabetes	______	______		☐	32
heart conditions	______	______		☐	33
hypertension	______	______		☐	34
chronic sinusitis & bronchitis	______	______		☐	35
arthritis & rheumatism	______	______		☐	36
rheumatic heart disease	______	______		☐	37
thyroid disease (specify type)	______	______	______	☐☐☐	38-40
liver disease (specify type)	______	______	______	☐☐☐	41-43
kidney disease (specify type)	______	______	______	☐☐☐	44-46
				A 1	79-80

Revised 18 October 1974

The occupations of the individuals were screened for possible occupational exposure to Cd prior to conducting the statistical analyses. The rationale behind this was to determine if any of the subjects could be considered to be non-representative of the population under study, that of a non-exposed group. The screen produced no individuals who could be considered to have a work-related exposure.

For each metal-matrix combination, the data are presented first in two ways. The geometric means for each age group are graphed and displayed. Next, the percentiles of the distribution of the subjects are calculated.

To investigate the distributional nature of the data, all the concentrations are used, irrespective of age or smoking habits. A frequency distribution is formed using these data and percentiles of the distribution estimated according to the formula,(18)

$$k^{th} \text{ percentile} = \frac{k - CF_{k-1}}{FR_k} W + LL_k$$

where

k = 5, 25, 50, 75, 95

CF_{k-1} = cumulative frequency of the class preceding the class of the k^{th} percentile

FR_k = frequency of the k^{th} percentile class

W = width of the interval

LL_k = lower limit of the k^{th} percentile class

The 5th and 95th percentiles are used to estimate the normal range of values expected in a white male of the overall age bracket, while the 25th and 75th represent the range for the middle 50 per cent of the population. Since the distribution of the concentrations is unknown, the 50th percentile, or median, represents the center of the distribution and provides a comparative figure for the mean value obtained.

There were modifications made to the data set prior to the conduct of the statistical analyses. After a preliminary investigation, and based upon treatment of data in other reports using similar data, it was determined to transform the data using a natural logarithm transformation to achieve greater homogeneity of variance for the ANOVA. Since the majority of the concentrations were less than one, the constant one was added to the concentration prior to the transformation(18). This reduces the total variability for values between 0 and 1. The transformation was:

$$Y = \ln (1 + X)$$

where

Y = transformed concentration
X = original concentration

This was used on all determinations except Zn, where the values were large enough to make it unnecessary to add the constant. To return the values to the μg/g scale, the formula:

$$x = e^y - 1$$

was used for all except the Zn, and

$$x = e^y$$

for Zn. It is easily verified that this produces the desired result.

Many of the determinations fell below the detection limit for the method, and a substitution was necessary for these values. The rule was to replace a "less than" value with one-half of the detection limit. The rationale behind this is that the limits are sufficiently low that there is little potential effect on the results.

For each metal-matrix combination, an Analysis of Variance (ANOVA) is conducted which has between-age group and within-age group factors, and a component for the sampling and analysis variation estimated from the duplicate samples. From the ANOVA, it is determined if age is a significant factor, and appropriate means and confidence intervals are generated. When the results specify that age is a significant factor, separate confidence intervals are calculated for each age group, except for the 60+ group in which there is only one individual.

If age is significant, the hypothesis of a linear trend is tested using an orthogonal contrast among the means, and a t-statistic is calculated to determine significance. The contrast is stated as:

$$H_o: - 5\mu_1 - 3\mu_2 - \mu_3 + \mu_4 + 3\mu_5 + 5\mu_6 = 0$$

where the coefficients are taken from a table in Snedecor and Cochran(18).

The sample means are substituted, and the test statistic is calculated. The test statistic follows Student's t distribution under the hypothesis, and the significance is determined by comparing this to a table of t with the degrees of freedom taken from the within-groups mean square.

From the data, separate means are determined across age groups for smokers and non-smokers, and a t-test is used to determine if there is a significant difference between the two groups. The sampling and analysis mean square is used for the sampling error term in these comparisons.

The results of these analyses on the autopsy data are shown in Section III. A below.

F. Design of Live-Volunteer Study

1. Specification of Target Population

The study specified two 24-hour samples of urine and feces to be collected from 80 white males, 20 in each of the age groups: 1 - 10; 20 - 30; 40 - 50; and 51+ years. These samples were to be collected from volunteer persons living in the study area who were not occupationally exposed to the metals being studied. To aid in the recruitment of volunteers, a questionnaire form was designed. The form directs itself to background information on volunteer individuals such as age, sex, smoking history, occupation, dietary habits, and health. Volunteer individuals meeting the residence, age and occupational requirements were offered $20 for delivery of the required excretia samples.

2. Recruitment of Volunteer Participants

The design approach was to recruit volunteer participants through organizations. Persons from the project team arranged meetings with officials of various organizations to establish cooperation with the study and to determine specific dates for recruitment activities. Information sheets were devised to distribute to the organizations and to potential recruits. Examples of the information sheets are presented in Figures 7 and 8. A description of the protocol to be used in collecting the excretia samples was also developed for use by the organizations in evaluating their desire to participate in the study and for use in describing to individuals the proper methods for sample collection. The protocol description is presented in Appendix A.

The general approach used to recruit participants for the study was as follows:

FIGURE 7. INTERNATIONAL CADMIUM STUDY

PURPOSE OF STUDY

To determine the present exposure levels of the population to the element cadmium. This is part of an international study in living persons and in autopsy samples.

PARTICIPANTS

Males, without occupational exposure to cadmium who live in the Dallas Metroplex, are required for this portion of the study.

SPECIMENS NEEDED

Two 24-hour urine samples
Two 24-hour stool samples

COLLECTION OF SPECIMENS

Collected during a one-week period. Instructions and specimen collection containers will be provided.

PAYMENT FOR SPECIMENS

$20 will be paid to each participant when specimens have been collected.

QUESTIONNAIRE FORMS

Each volunteer will complete a short questionnaire form. Based on the turnout of volunteers, participants will be selected. Distribution of ages will be the principal criterion for selection.

NOTIFICATION OF SELECTION

Participants will be notified by mail of their selection. A date, time, and place for an initial meeting will be specified in the notification to participants.

FIGURE 8. SAMPLE INFORMATION SHEET FOR VOLUNTEER RECRUITMENT

HOW ABOUT AN EXTRA $20

SUMMARY

To determine the present exposure levels of the population to the element cadmium, Southwest Research Institute is performing a study for the Environmental Protection Agency. The population to be studied are males, without occupational exposure to cadmium, who live in the Dallas metro area. Toward this purpose, samples of urine and feces will be obtained and analyzed chemically for the presence of cadmium.

PARTICIPANTS NEEDED

80 males - 20 in each of the following age groups:

1-10 years
20-30 years
40-50 years
50+ years
} 20 persons in each

All employees, medical staff, and families (male) are eligible.

SAMPLES NEEDED FROM EACH VOLUNTEER PARTICIPANT

Two 24-hour urine samples
Two 24-hour feces samples

SAMPLE COLLECTION

These samples will be collected during a one-week period and each volunteer will be paid $20 when the samples have been collected. Volunteers will be asked to complete a short questionnaire form. Sample collection containers will be provided.

PAYMENT FOR VOLUNTEER PARTICIPANTS

$20 for services rendered paid to each volunteer.

Complete Information Regarding this Program will be Given Out

Where: Assembly Room - Veal Building

When: Wednesday, September 24, 1975, 1-5 p.m.

(1) Information sheets were provided to prospective volunteers and detailed information regarding the study was presented by a member of the project staff.

(2) A questionnaire form was obtained from all individuals volunteering to participate.

(3) The questionnaire forms were examined and a set of qualified participants were selected.

(4) The participants were notified of their selection and a time and place established for provision of sample collection containers and instruction to the participants, and the obtaining of a signed informed consent document from each participant.

(5) Samples were then collected by the individuals and provided to the project staff (in the sample collection containers).

(6) Each individual completing his sample delivery was given $20 in compensation for his service to the project.

(7) The samples were prepared and shipped under refrigeration to the San Antonio Laboratories for analysis.

Initial arrangements were made for recruitment of volunteer participants through the Baylor University Medical Center, 3500 Gaston Avenue. Contacts were made with Mr. Herman Walker, Associate Director, Personnel; Dr. George Race, Head, Department of Pathology; and Mr. Clarence Borgens, Director, Out-Patient Clinic. Mr. Borgens administers various research activities at the hospital and he was given the duty of serving as principal contact for this study.

Borgens provided information that 923 male persons were employed at the Center at that time, of which 609 were white. The distribution of ages was heavy on the younger side. In the recruitment activities no mention was made to the individuals of the racial requirement. Volunteers were to be recruited from all males and some non-whites were to be selected as volunteers. Analysis of the samples collected was to remain at the discretion of the study team. Borgens suggested that recruitment information should be distributed with pay envelopes. This would maximize attention to the study. Background materials provided to Mr. Borgens were rewritten and were to be attached to pay envelopes on a prescribed payday. Mr. Borgens then made arrangements to inform the administrative and supervisory staff of the Center in the biweekly administrative meeting preceding the distribution of study information with pay envelopes.

At the appointed time and place, volunteer participants were recruited at Baylor University Medical Center. The initial date of recruitment was Wednesday, September 24, after paychecks (and study information) were distributed the previous Thursday. The results of the initial recruitment were far from a complete success: 29 potentially acceptable participants were obtained out of the 80 required. Consideration of the reasons for the poor showing led the study team to conclude that a longer than optimum length of time had passed between the distribution of study literature and the actual recruitment activities. A second phase of recruitment activity was then planned for the next distribution of paychecks, Thursday, October 2, 1975. A member of the project team was made available both that same afternoon (October 2) and the next day in the meeting room to talk with potential volunteers.

A revised information sheet was developed (Figure 9) and distributed with pay envelopes. Results of this second phase of recruitment activities were still insufficient for performance of the study. The age group 20-30 was more than filled (34 volunteers, 20 needed), but the other age groups were lacking. At the end of the recruitment activities at Baylor, only 40 of the necessary 80 volunteers of specified ages were in hand.

It was then decided to attempt to recruit volunteers from the ranks of men's service organizations. The Downtown Lions' Club was approached with the idea and they agreed to have one of the study team delivery a recruitment pitch to a regularly scheduled meeting. The result was an additional five volunteers, or a total of 45 of the necessary 80.

Simultaneous to the recruitment activities of the Cadmium Study, another study was being accomplished in Dallas by the study team: "Epidemiologic Study of the Effect of Exposure to Automobile Traffic on the Blood Lead Levels of Persons in Selected Age Groups," EPA Contract 68-02-2227. In that study, household surveys were being performed in certain areas of the city. Members of the survey team were asked to distribute information sheets to more than 100 residences and the following day by interviewers who went door-to-door to recruit volunteers. Results of this phase of recruitment were such that all age groups but the oldest (50+ years) were complete.

Figure 9.

MORE PARTICIPANTS NEEDED

Your help is needed for a research study which involves a determination of the present exposure levels of men in the Dallas Metroplex to the element cadmium. Baylor University Medical Center has previously agreed to cooperate with Southwest Research Institute in performing this research project for the U.S. Government Environmental Protection Agency. The study involves analysis of urine and stool specimens with no risk to those participating. Thirty volunteers have been obtained and an additional ninety volunteers are needed to accomplish the study goal. Such research studies are entirely dependent on participation by persons such as yourselves.

Participation is entirely voluntary. Those who are selected will receive $20 each for their part in the study. All male members of the employee staff, house staff and medical staff are eligible to participate and male family members of all employees are also welcome, especially children ages 1-10 years.

Representatives from Southwest Research Institute will be in the Braniff Room on Thursday afternoon, October 2, 1975, from 2:00-4:00 P.M., and on Friday, October 3, 8:00-10:30 A.M. for the purpose of recruiting volunteers.

HOW ABOUT AN EXTRA $20

The remaining volunteers (approximately 10) in the 50+ age group were recruited by screening the questionnaires obtained in the lead study mentioned previously to determine the likelihood of a male person residing at the household who fit the required age category. Telephone calls were made to those families seeming to meet the criteria and the remaining volunteers were obtained.

3. Sample Collection, Storage, Shipping and Analysis

a. Collection

The initial meeting with the volunteers selected for this study covered a number of points. The purpose of the study was explained in full to each participant and their questions were answered by members of the SwRI survey team. Each participant was then asked to fill out a "Volunteers Informed Consent" a copy of which is found in Appendix B. It was explained to each volunteer that their participation in this research study was strictly voluntary and that at any time they could withdraw from the study. The benefits, inconveniences, hazards, discomforts, or risks of their participation in this study were explained to them. At this point, each volunteer was asked to sign the Informed Consent. The signature was witnessed and signed.

Instructions were next given on the types of samples to be collected and the precautions to be observed. Two 24-hour urine and feces samples were to be collected from each participant. There was no restriction placed on food or drink during the collection of samples. Each participant was given a shopping bag that contained pre-labeled two-liter urine collection containers (two each) and one-liter feces containers (two each). An extra urine container was also provided. In addition, a portable camping toilet with disposable plastic bags was also loaned to each family of volunteers to facilitate feces collection.

The volunteers were instructed to begin collection of the first 24-hour urine and feces specimen upon arising in the morning. Collection of the first specimen continued until the following morning in containers labeled "first sample." It was stressed that all of the urine and feces eliminated during this time period be collected. At the end of the first 24-hour sample, the containers marked "second sample" were used to continue the urine and feces collection. The volunteers were instructed not to contaminate their samples of urine with feces, tap water, etc. Similarly, feces samples should not be contaminated with urine or toilet paper. This avoidance of contamination of the samples was reinforced when the participants were told that they would receive a summary of the results.

b. Storage

Participants were asked to keep their specimens cool, if possible, after collection and prior to delivery to the survey team. For those participants selected from the local hospital, instructions were given where to bring the samples when they reported for work. For those participants recruited either from organizations or from house-to-house surveys, instructions were given as to the time that a member of they survey team would come to their home to pick up the samples.

Some participants recruited from the hospital collected their samples during the week. Thus these people carried their containers with them during their working hours. Most participants found this too inconvenient and collected their specimens at home over a weekend. Other than short trips to neighborhood stores, the participants remained home during the weekend and so had easy access to their containers.

After the second set of samples were collected from each participant, each was paid twenty dollars and thanked for their cooperation in the study. They were reminded that when all the analyses were complete they would receive a summary of the results.

After the 24-hour samples were collected from the participants, the total volume of the urine collected for each of the two days was measured. A 150-ml aliquot of a thoroughly mixed 24-hour urine sample was transferred to a 175-ml polyethylene container. The contents were then acidified to make the urine 1% nitric acid (Reagent Grade). The urine sample was then placed on dry ice and kept frozen until analyzed. The total feces sample from a 24 hour period was also weighed and placed on dry ice and kept frozen until analyzed.

c. Shipment

All feces and urine samples were frozen with dry ice and packed in insulated ice chest. Sufficient dry ice was added to each ice chest to keep the samples frozen for two days.

The insulated ice chests were shipped by air freight to the San Antonio Laboratories. Feces and urine samples were placed in a walk-in freezer until ready for analysis.

d. Analysis

Urine and feces samples were analyzed for Cd by atomic absorption spectrophotometry using the procedures given in the Methods section.

4. Questionnaire

a. Questionnaire Form Development

To properly recruit volunteer participants for use in the study, a number of items of background information were required. These include age, sex, race, length of residence in the area, and occupation. In addition, other background characteristics of the volunteer participants were desired. These included smoking history, incidence of certain chronic illnesses, and certain dietary habits which might relate to intake of the metals of interest to this study.

To accomplish the gathering of the required and desired background information, a questionnaire form was developed as shown in Figure 10. The first step in development of the form was development of the information content of the form. A set of questions was then generated which, when answered, would provide the required information. These questions were formatted to fit the design of a one-page (both sides) form intended for self-administration with instructions from a person familiar with the form. All questions except that for race were to be answered directly by the volunteer. The race question was coded on the reverse side of the form with the initials IMNOWO (Indian, Mexican, Negro, Oriental, White, Other). The form is designed for the person administering the recruitment activities to observe and record the information regarding race by marking the appropriate initial after collecting the form from the individual.

After the form was designed, a draft version of the form was submitted to OMB for clearance to use the form with the general public. A justification document (Appendix C) was prepared and submitted with the draft form. OMB clearance was obtained, and the clearance number (158-S75007) was placed on the final version of the Cadmium Questionnaire form.

b. Questionnaire Administration

At the meetings with potential volunteers the purpose of the study was explained and the type of samples to be collected were described. A question and answer period followed. Those individuals still interested in participating were then given the Cadmium Questionnaire form (Figure 10). The SwRI staff member conducting the meeting would then describe the form, its purpose, and answer any questions about it.

The potential volunteer filled out the form and it was reviewed by a SwRI staff member. The volunteer was then told if he met the requirements and if was accepted to participate. Those not selected were told the reason why and thanked for the interest.

Figure 10.

OMB#158-S75007

STAFF USE ONLY
Cols. 1-4
ID# ☐☐☐☐

CADMIUM QUESTIONNAIRE

1. Name: ______________________________ 5-30
(Last Name) (Initials)

2. Address: Street ______________________________ 31-50
City ______________ State ______________ 51-65
Zip Code ______________________________ 66-70
Telephone, Residence ______________________ 71-77
Telephone, Work ____________ Ext. ________ P 1 79-80

5-15

3. How old were you on your last birthday? ______ years ☐☐ 16-17

4. What is your present occupation? ☐☐ 18-19

____

5. How many times have you changed occupations during the past five years? _____ times ☐ 20

6. Your present employer is: ☐☐☐ 21-23

____

7. How long have you been employed by your present employer? ________ years ☐ 24

8. How many years have you lived in your present city or town? _________ years ☐ 25

9. Have you ever smoked as many as five packs of cigarettes, that is as many as 100 cigarettes during your entire life? ☐ 26

(1) Yes (2) No

10. Do you now smoke cigarettes? (1) Yes (2) No ☐ 27

11. If you are a current or ex-cigarette smoker, how many cigarettes do (did) you smoke per day? ☐ 28

(1) 1-5 cigarettes per day
(2) 6-14 cigarettes per day
(3) 15-25 cigarettes per day
(4) 26-34 cigarettes per day
(5) 35 or more cigarettes per day

12. If you are a current or an ex-cigarette smoker, how old were you when you first started smoking? __________ years ☐☐ 29-30

13. If you are an ex-cigarette smoker, how old were you when you last gave up smoking? _________ years ☐☐ 31-32

14. Have you ever been diagnosed as having any one of the following chronic illnesses:

	(1) No	(2) Yes	Type		
Malignancies	___	___		☐	33
Diabetes	___	___		☐	34
Heart conditions	___	___		☐	35
Hypertension	___	___		☐	36
Arthritis and rheumatism	___	___		☐	37
Rheumatic heart disease	___	___		☐	38
Thyroid disease (specify type)	___	___	___________	☐☐☐	39-41
Liver disease (specify type)	___	___	___________	☐☐☐	42-44
Kidney disease (specify type)	___	___	___________	☐☐☐	45-47

15. Are you presently following any of the dietary regimens listed below:
(Check all that apply.)

(1) Bland food ulcer diet
(2) Diabetes
(3) Weight-watchers/reducing
(4) Organic food diet
(5) Vegetarian
(6) None of these

☐ 48

16. How often do you eat shellfish such as shrimp, oysters, crabs, lobster or clams?

(1) More than once a week
(2) About once a week
(3) About once every two weeks
(4) About once a month
(5) Less than once a month
(6) Never

☐ 49

17. How often do you eat liver or kidney?

(1) More than once a week
(2) About once a week
(3) About once every two weeks
(4) About once a month
(5) Less than once a month
(6) Never

☐ 50

YOU HAVE COMPLETED THE QUESTIONNAIRE.
THANK YOU FOR YOUR COOPERATION.

IMNOWO 123456

☐ 51

Revised 7 August 1975

P 2 79-80

5. Statistical Methods

The statistical analyses of the participant data follow the format of the autopsy cases shown above. The geometric means for each age group are graphed and percentiles of the entire sample under study are presented to describe the data set.

The ANOVA is conducted on the transformed data, as before, and significant results reported. The difference between the two sets of analyses comes in the treatment of the effect of smoking. For these data, three subgroups were separated: current smokers, individuals who had smoked previously but did not do so currently (labeled current non-smokers), and non-smokers. The differences between the smoking group and each of the other groups are tested.

For the participant data, only the results from the individuals ages 20 and over were used in these comparisons. The reason behind this is that no smokers were reported in the first two age groups. Since age can be a significant variable relating to Cd concentration, it was determined that only those groups be used which had both smokers and non-smokers among the participants.

III. RESULTS

A. Autopsy Study

1. Target Cell Size

Acceptable background information was collected for 164 cases. The spectrum of ages for which the information was collected and the tissue samples provided to the study team are as follows:

Age (years)	No. of Cases
10-19	33
20-29	38
30-39	33
40-49	28
50-59	31
60-69	1

More than the required number of cases were collected in all of the age groups except one. In the 40-49 age group there were two cases which could not be used because the information sheets indicated one of these individuals had not lived within the Dallas area for the required length of time and the other did not belong in that age category.

There was a lag time between receiving the samples and receiving the information sheets from the Medical Examiner's office. In some cases the age information supplied with the tissues would not be the same as recorded on the information sheets. The Medical Examiner's Office indicated the information recorded on the data sheets was the correct one. In these two cases, the information sheets did not arrive in time to collect other cases in the 40-49 age group.

2. Questionnaire Data

The autopsy subjects selected for this study were all white males, residing in the Dallas area. Other information obtained on the subjects by the questionnaire discussed previously is summarized below.

The individuals were selected to be from a non-exposed environment, and as a result, their length of residence at both their current residence and in the city or town was investigated. Of the total of 164 cases, 72 or 44 per cent had resided at their current address two years or less, 24 or 15 per cent had lived at the same residence for two to five years, and the remainder over five years.

The years of residence within the same community showed 26 cases or 16 per cent being residents three years or less, another 12 individuals or 7 per cent residents from three to six years, and the remaining 77 per cent as residents for over six years. Thus, the majority of the cases could be classified as non-exposed for a period in excess of six years.

The presence of air-conditioning in the home can reduce the exposure of individuals to trace metals, since it tends to remove particles from the air being drawn through the system into the home. The subjects were classified as having no air-conditioning, window unit, or central system. There were 10 cases where no information could be obtained on air-conditioning, but of the remaining 154, only 11 were reported to have no air-conditioning in the home. Central systems were reported in 93 cases, while the remaining 50 were reported to have window units.

A limited medical history was requested on these individuals, and the results are summarized in Table 10. The chronic illnesses of interest, the frequency of a positive response, and the percentage of the total sample represented are shown. The most frequently occurring illnesses were hypertension and chronic sinusitis and bronchitis. The respondents were asked to specify type on the last three illnesses. The thyroid diseases reported were one case of Graves disease and one low thyroid. Seven diagnoses of cirrhosis, two of alcoholism, and two of acute infectious hepatitis were reported for the liver diseases. For kidney diseases, three cases of kidney stones. one of bladder problems, and one of congenital absence were reported.

The smoking habits of the individuals were examined and 116 of the cases were reported to smoke cigarettes regularly. Of the remaining 48, 14 had been reported to have smoked cigarettes (at least 100 in lifetime) previously.

3. Single Tissue Results

The trace metal data obtained in this study are presented as appendices to this report. These data were submitted to statistical analysis according to the procedures outlined in Section II. E. 5 above and the results are presented below for each tissue under study.

a. Kidney

i. Cadmium

The raw data on Cd concentration is presented in Appendix F. The geometric means were calculated for each age group and

TABLE 10. SUMMARY OF CHRONIC ILLNESSES REPORTED FOR AUTOPSY CASES

Illness	Positive Responses	Percent
Tuberculosis	2	1.2
Malignancies	7	4.3
Asthma-Hay Fever	13	7.9
Diabetes	8	4.9
Heart Conditions	17	10.4
Hypertension	27	16.5
Chronic Sinusitis and Bronchitis	25	15.2
Arthritis and Rheumatism	3	1.8
Rheumatic Heart Disease	8	4.8
Thyroid Disease	2	1.2
Liver Disease	11	6.7
Kidney Disease	5	3.0

are plotted in Figure 11. As can be seen, the concentration tends to increase with age through the 40-49 group, then level off.

The statistical analyses are summarized in Table 11 for Cd in kidney tissue. Percentiles of the distribution of the entire 164 subjects were calculated and these are presented in the table. The median of the data set was 20.03 μg/g, compared to an overall mean of 17.96 μg/g. The range of the data with upper and lower five per cents removed was 54.65 μg/g (60.84 - 6.19), and the interquartile range was calculated to be 19.94, where the middle 50 per cent of the concentrations could be expected to be found.

From the ANOVA table, the F-ratio for significance of the age factor is 9.02 and is significant beyond the one per cent level. From the transformed means shown in the table, an apparent linear trend exists, and this hypothesis is tested using an orthogonal contrast among the means. The calculated t-statistic is 12.15, and this trend is found to be significant beyond the one per cent significance level.

For each age group, a confidence interval was calculated using the within group mean square and translated back to the μg/g scale. These intervals are presented in the summary table.

The sampling and analytical variation for these data is estimated by a standard deviation of 0.124 in the logarithmic scale which gives 1.132 upon exponentiating.

To evaluate the effect of cigarette smoking on Cd concentration in kidney tissue, means are calculated separately for the smoking and non-smoking individuals. These are 3.009 and 2.595 in the transformed scale, respectively, and the calculated t has a value of 19.40. This is significant beyond the 0.1 per cent level, and the conclusion is that the smokers have significantly higher concentrations of Cd. The difference between the two groups is 6.87 μg/g average concentration.

ii. Lead

The concentrations of Pb in kidney tissue are shown in Appendix G. The geometric means were calculated and are presented in Figure 12 plotted against the age groups. There is no apparent tendency for any increase or decrease related to the age of the subject.

The summary of the statistical analysis is contained in Table 12. The percentiles of the observed distribution are calculated, and indicate a median value of 0.47 μg/g, with an expected range of 0.19 to 1.19 μg/g. The interquartile range is estimated as 0.33 to 0.73, for the middle 50 per cent of the concentrations.

FIGURE 11. CADMIUM CONCENTRATION IN KIDNEY vs AGE GROUP

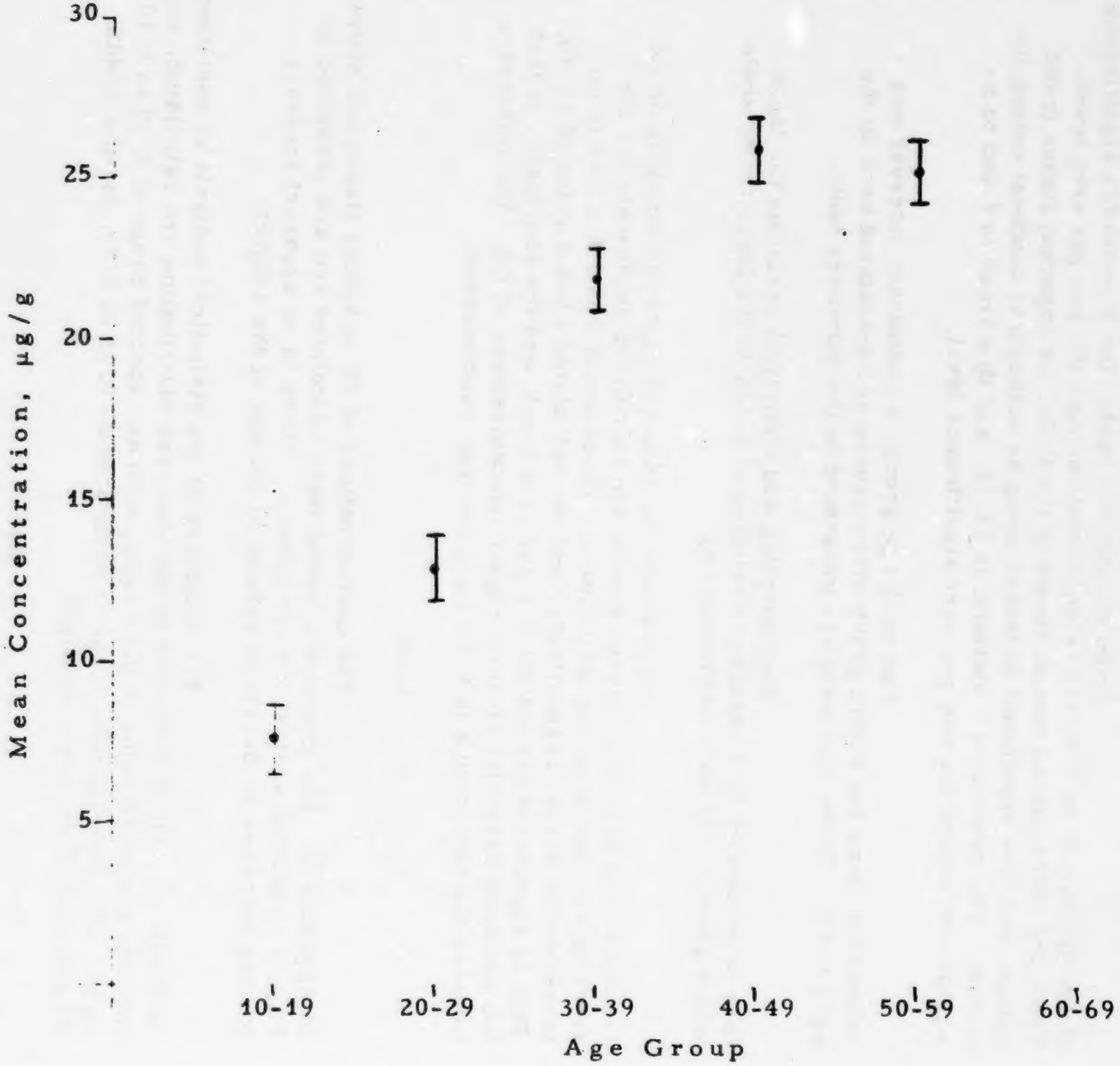


TABLE 11. STATISTICAL SUMMARY FOR CADMIUM IN KIDNEY TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, µg/g	6.19	11.09	20.03	31.03	60.84

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	31.1829	6.2366	9.02	0.01
Within Groups	158	109.2498	0.6915		
Sampling and Analysis	164	2.5471	0.0155		
Total	327	142.9798			

	Age Group					
	1	2	3	4	5	6
Mean $\boxed{\ln(1+x)}$	2.160	2.638	3.136	3.292	3.271	3.302
Sample size	35	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-19	7.671	5.527 - 10.549
20-29	12.985	9.740 - 17.211
30-39	22.012	16.322 - 29.569
40-49	25.897	18.767 - 35.598
50-59	26.172	18.648 - 34.304

FIGURE 12. LEAD CONCENTRATION IN KIDNEY vs AGE GROUP

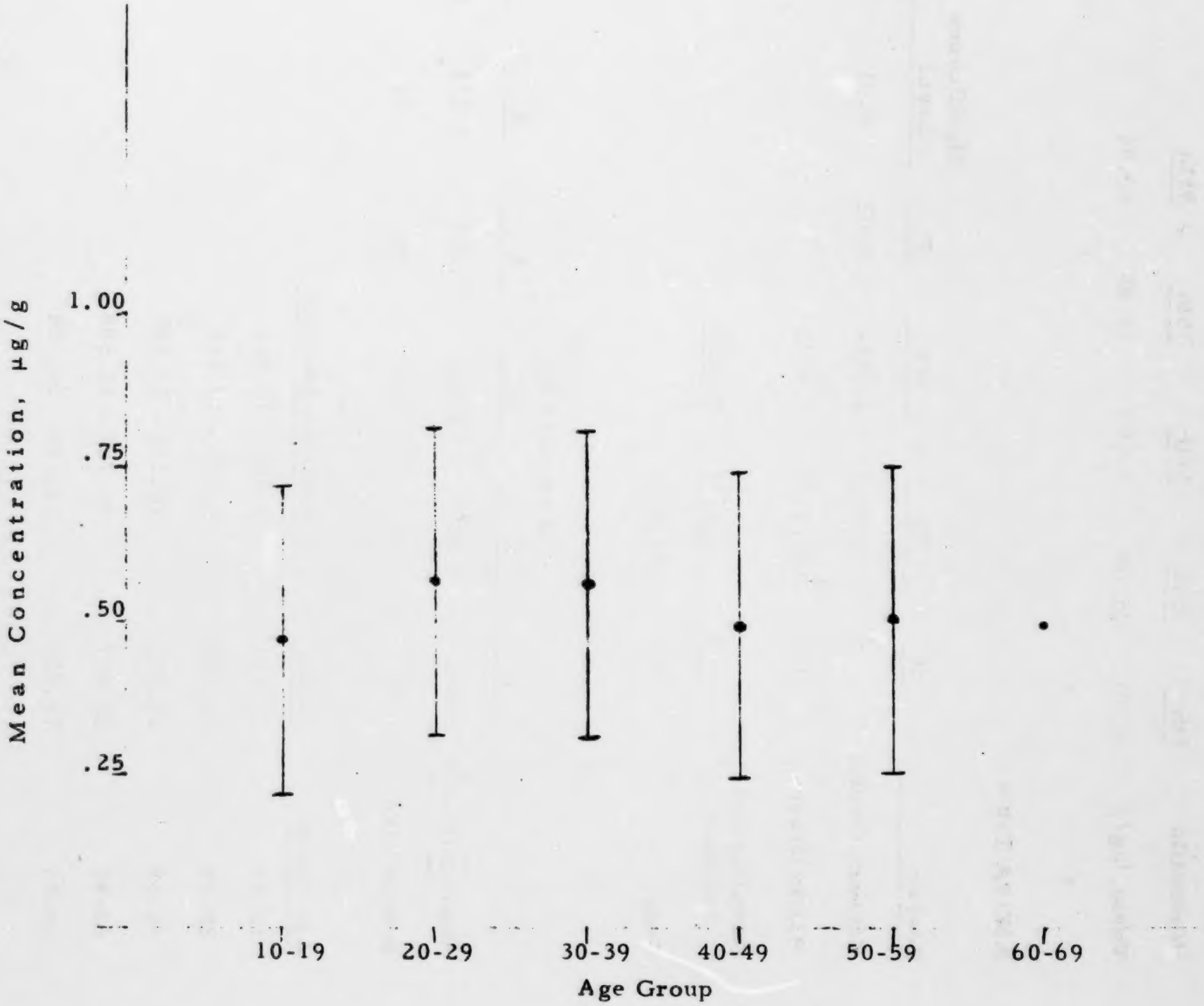


TABLE 12. STATISTICAL SUMMARY FOR LEAD IN KIDNEY TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, µg/g	0.19	0.33	0.47	0.73	1.19

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.3407	0.0681	1.00	N.S.
Within Groups	158	10.7735	0.0682		
Sampling and Analysis	164	0.3962	0.0024		
Total	327	11.5104			

Age Group

	1	2	3	4	5	6
Mean $\lfloor \ln(1+x) \rceil$	0.383	0.451	0.446	0.401	0.408	0.401
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.523	0.464 - 0.586

The ANOVA gives an F-value of less than one for between age groups and the age factor is not determined to be significant. The highest concentrations tend to be in the 20-39 age brackets, after which a slight decrease is observed, and the average values remain fairly constant.

The overall mean of 0.421 in the transformed scale is used to calculate a confidence interval on average Pb concentration in kidney tissue of 0.464 to 0.586 µg/g since no age effect is noted.

The variation between duplicate samples is estimated by a standard deviation of 0.049 in the transformed scale, which gives 1.050 upon exponentiating. This indicates relatively good agreement between the duplicate samples.

The mean for the 116 smokers was 0.636 compared to 0.582 for non-smokers in the transformed scale. The calculated t-statistic was 5.33, significant beyond the 0.1 per cent level. This represents a difference in average concentration of 0.099 µg/g between the two groups.

iii. Mercury

The results of the Hg analyses on kidney tissue are shown in Appendix I. The geometric means for each age group are calculated and plotted in Figure 13. The highest mean is in the 20-29 age group, then a levelling off is noted for the next three ages. The last point represents only a single individual and is not necessarily indicative of a trend.

The summary of the statistical analyses is contained in Table 13 for Hg in kidney. The percentiles of the distribution are estimated from the 164 autopsy cases and these are shown in the table. The median concentration was 0.430 µg/g, and the range of normal concentrations was from 0.052 to 2.597 µg/g. The interquartile range was from 0.224 to 0.781 µg/g.

The ANOVA of the data gives an F-ratio for significance of less than one, and the between groups factor is again determined to be nonsignificant. The means of the transformed data for each group are shown in the table for comparison purposes.

The overall mean of 0.467 is used to calculate a confidence interval on the true mean of the population. The 95 per cent limits are from 0.462 to 0.742 µg/g.

FIGURE 13. MERCURY CONCENTRATION IN KIDNEY TISSUE vs AGE GROUP

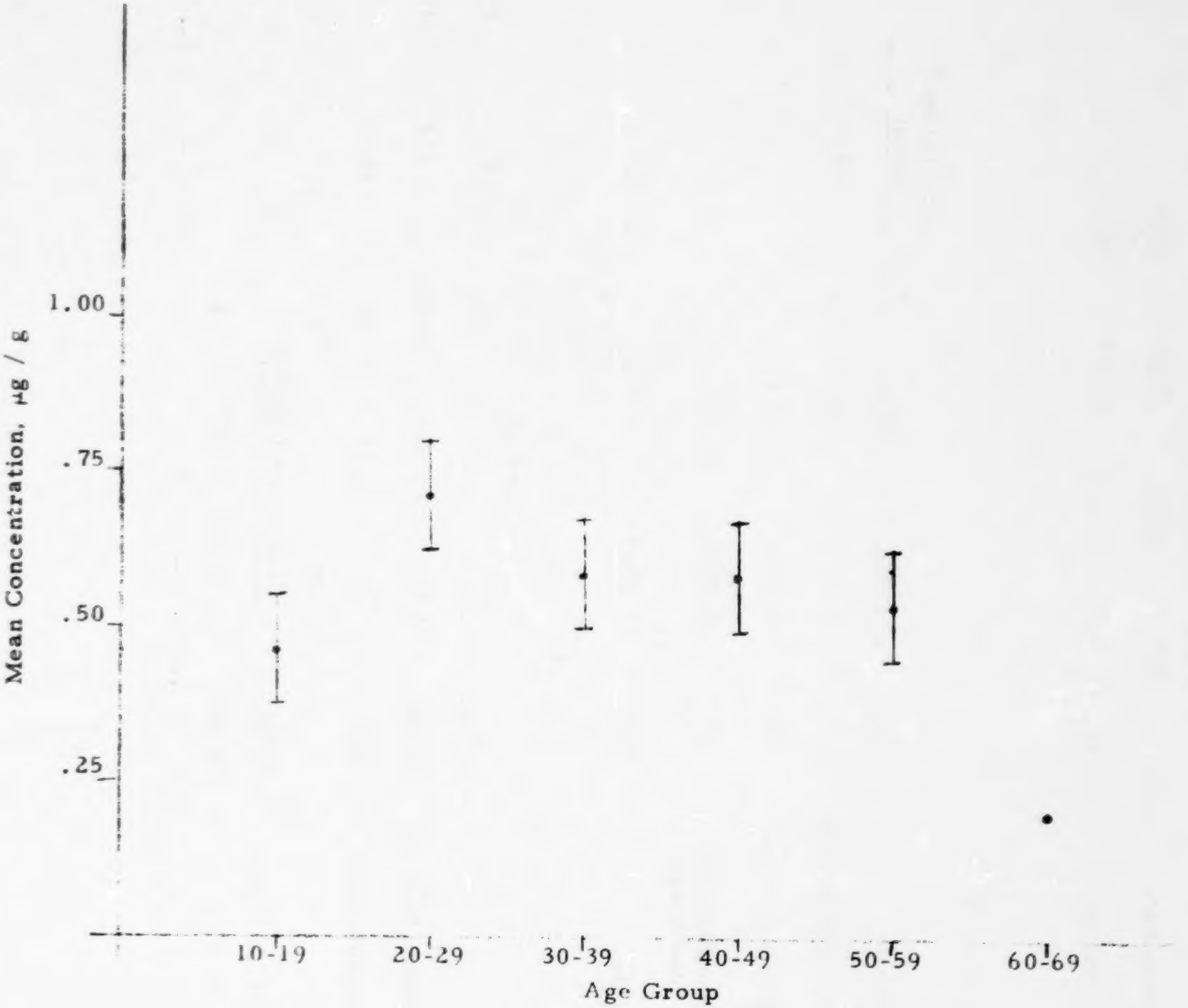


TABLE 13. STATISTICAL SUMMARY FOR MERCURY IN KIDNEY TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, μg/g	0.052	0.224	0.430	0.781	2.597

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.6102	0.1220	1	N.S.
Within Groups	158	51.5695	0.3264		
Sampling and Analysis	164	0.1070	0.0007		
Total	327	52.2867			

Age Group

	1	2	3	4	5	6
Mean $\left[\ln(1+x)\right]$	0.380	0.542	0.491	0.486	0.432	0.185
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.595	0.462 - 0.742

The expected variation between two samples of the same kidney tissue is estimated from the sampling and analysis term of the ANOVA. The estimated standard deviation is 0.026 in the transformed scale, which gives a value of 1.026 upon taking the antilog. This implies good precision in the duplicate results.

The mean for the smokers in the sample was 0.441 versus 0.532 for the non-smokers, in the transformed scale. The calculated t-statistic is -153.08, which indicates that significantly lower concentrations of Hg were observed in the smokers. The difference translates to 0.148 μg/g in average concentration.

iv. Zinc

The final analyses on kidney tissue were for zinc content. The geometric means for each age group are plotted in Figure 14 with the means taken from the summary table in Appendix H.

The statistical analyses are summarized in Table 14. The percentiles of the distribution were estimated from the entire 164 individuals. The median of the data set was 46.91 μg/g with an interquartile range of 37.54 to 54.22 μg/g. The 5th to 95th percentile range was from 28.36 to 80.50 μg/g.

The ANOVA on the transformed data is also shown in Table 14. The F-ratio for between age groups is significant at the one per cent level and age is determined to have an effect on these data. A t-test for the linear contrast proved nonsignificant, but it appeared to be unduly affected by the value for group six. Rerunning the contrast using only the five groups with substantial numbers gives a t-statistic of 3.60, which exceeds the one per cent level of the t-distribution. This result is more realistic in view of the observed means, and age is a significant factor, with the tendency for the concentration to increase concurrently with age.

Since age is a significant factor, separate confidence intervals are calculated for each age group using the within group mean square for the error term.

The sampling and analytical error associated with these results is determined from the ANOVA. The mean square for sampling and analysis gives a standard deviation estimate of 0.124 in the transformed scale. Transforming this to the original scale gives 1.132, and the estimated variability between duplicate samples is 13.2 per cent.

FIGURE 14. ZINC CONCENTRATION IN PANCREAS vs AGE GROUP

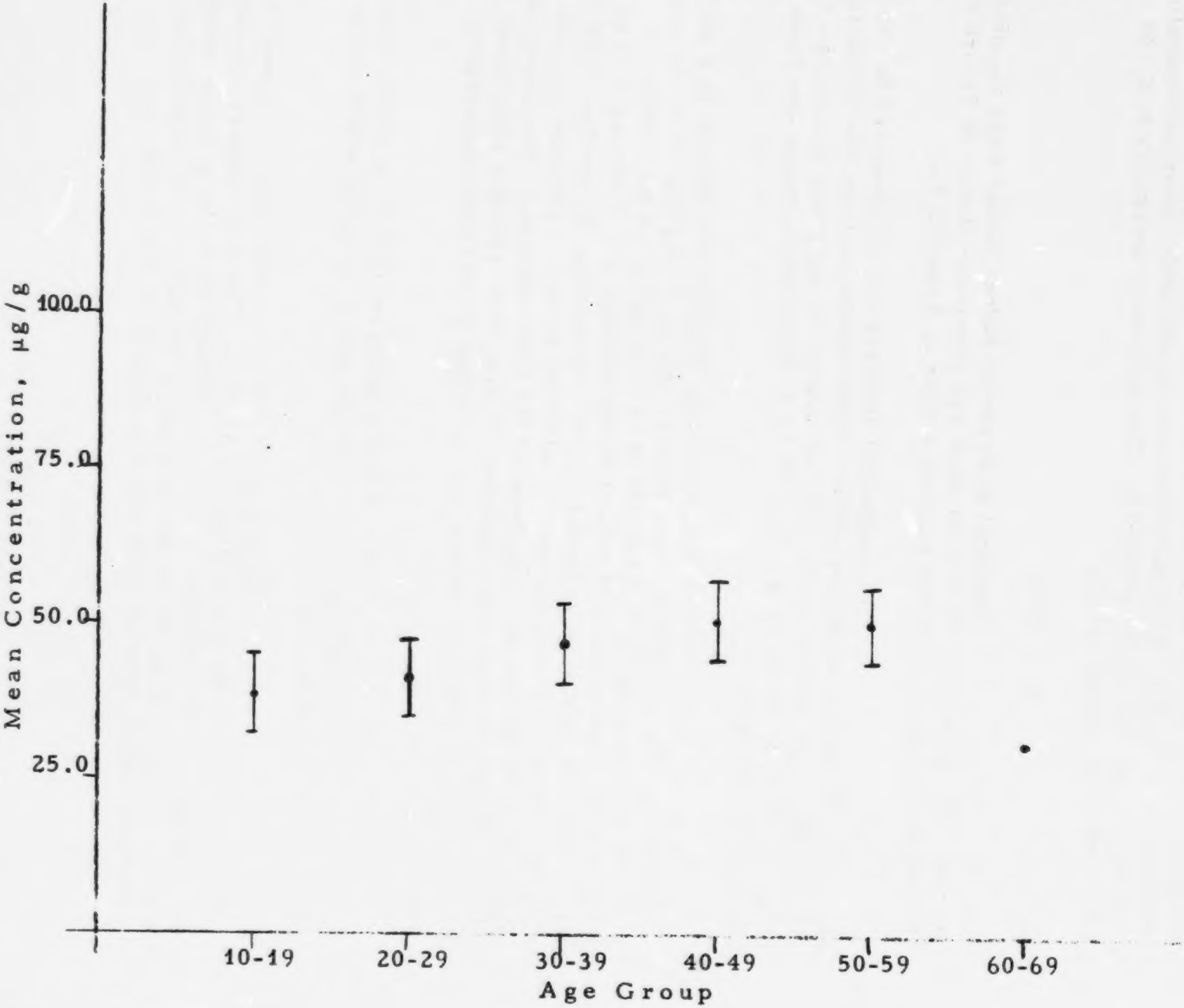


TABLE 14. STATISTICAL SUMMARY FOR ZINC IN KIDNEY TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, μg/g	28.36	37.54	46.91	54.22	80.50

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	2.0871	0.4174	3.14	0.01
Within Groups	158	20.9918	0.1329		
Sampling and Analysis	164	2.5213	0.0154		
Total	327	25.6002			

	Age Group					
	1	2	3	4	5	6
Mean (lnx)	3.639	3.735	3.852	3.922	3.914	3.424
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-19	38.05	33.62 - 43.12
20-29	41.89	37.30 - 47.04
30-39	47.09	41.60 - 52.30
40-49	50.50	44.12 - 57.80
50-59	50.10	44.08 - 56.94

The transformed means for the smoking and non-smoking groups, respectively, were 3.85 and 3.73. The t-statistic for this comparison is calculated as 5.39, which indicates a significantly higher average concentration among smokers. The difference is calculated as 5.31 µg/g average concentration between the two groups.

v. Summary of Kidney Results

The results for kidney tissue are summarized in Table 15. Cadmium and zinc showed an increase with age, while lead concentrations peaked at the 20-39 ages, and the mercury results showed no age tendency.

The smoking group had significantly different concentrations on all metals. Higher concentrations of Cd, Pb and Zn were observed and lower levels of Hg.

b. Liver

i. Cadmium

The analytical results for Cd in liver samples are contained in Appendix F. Using the geometric means presented for each age group, a graph is constructed and presented in Figure 15. The tendency is noted for Cd concentration to increase through the 30-39 group, followed by a levelling off for the 40-49 and a drop-off at 50-59. The 60-69 group result is based on only one individual and is not considered representative.

The statistical summary is shown in Table 16. The percentiles of the distribution of the 164 values are presented. The median of the data set is estimated as 1.14 µg/g with a range of 2.45 (0.22 to 2.67) between the 5th and 95th percentiles, and an interquartile range (25th to 75th) of 1.01 µg/g.

The ANOVA table along with the transformed means are also down in the table. The F-ratio for between age groups is 3.30, which is significant beyond the one per cent level with 5 and 158 df. The test for linear trend is significant, and the tendency for concentration to increase with age is confirmed.

On this basis, confidence intervals are calculated for each age group (except 60-69), and are presented in the summary statistics portion of Table 16.

TABLE 15. SUMMARY OF RESULTS ON KIDNEY TISSUE

Metal	Age Effect	Linear Trend	Smoking Effect
Cadmium	Significant	yes, increasing to 40-49 group	Higher concentration among smokers
Lead	Not significant Highest in 20-39 groups	--	Higher concentration among smokers
Mercury	Not significant	--	Lower concentration among smokers
Zinc	Significant	yes	Higher concentration among smokers

FIGURE 15. CADMIUM CONCENTRATION IN LIVER vs AGE GROUP

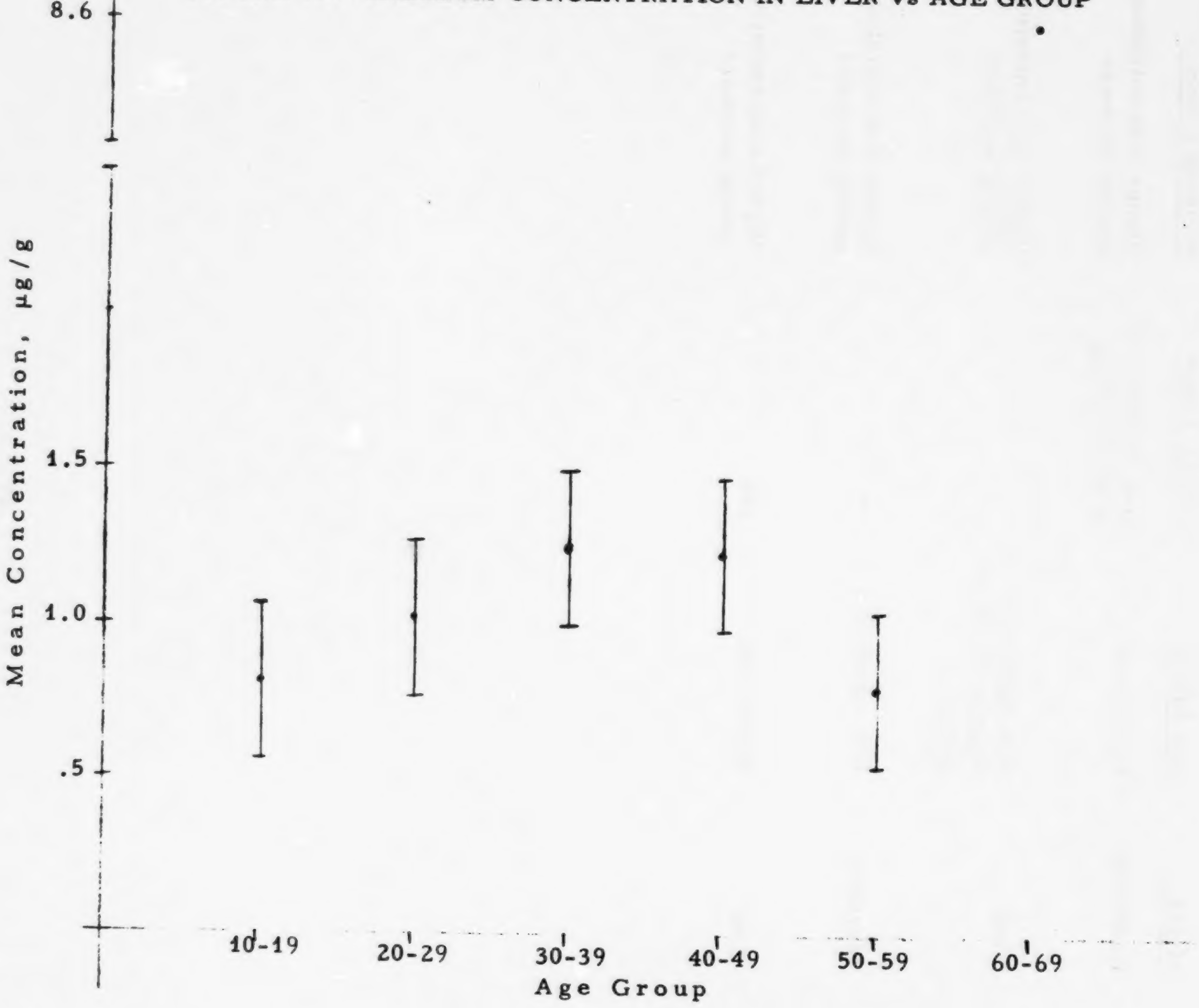


TABLE 16. STATISTICAL SUMMARY FOR CADMIUM IN LIVER TISSUE

	Percentiles				
Percentile	5th	25th	50th	75th	95th
Value, μg/g	0.22	0.65	1.14	1.66	2.67

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	3.5467	0.7093	3.30	<0.01
Within Groups	158	33.9395	0.2148		
Sampling and Analysis	164	1.1105	0.0068		
Total	327	38.5967			

	Age Group					
	1	2	3	4	5	6
Mean[ln(1+x)]	0.598	0.707	0.833	0.827	0.790	2.259
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-19	0.818	0.553-1.130
20-29	1.028	0.751-1.349
30-39	1.300	0.964-1.694
40-49	1.286	0.925-1.716
50-59	1.203	0.872-1.593

The sampling and analysis mean square gives an estimated standard deviation of 0.082 in the transformed scale. Taking the antilog gives a value of 1.085 for relatively good precision. As the name indicates this is attributable to differences both between samples from the same tissue and to sample preparation and analysis.

The smoking and non-smoking means are calculated in the transformed scale as 0.785 and 0.686, respectively, for the two groups. This results in a calculated t-statistic of 6.94 which is significant beyond the 0.1 per cent level. The conclusion is, then, that smokers exhibit higher average concentrations of Cd in liver tissue than non-smokers. The estimated difference in average concentration is 0.207 μg/g.

ii. Lead

The Pb determinations are shown in Appendix G. The means for each age group are plotted and shown in Figure 16. For these data, the highest values occur in the 20-39 ages, with some decrease after that point.

The summary table is shown as Table 17. The percentiles of the distribution are calculated and presented for the 164 individuals. The median concentration was 0.81 μg/g, and the 5th to 95th percentile range was 0.166 μg/g. The interquartile range, by comparison was estimated to be 0.64 μg/g.

From the ANOVA table it is determined that the age group differences do not exceed expected variation among individuals and that age is not a significant factor in these determined concentrations. The transformed means are shown in the table and indicate that no tendency does exist to increase with age.

A single confidence interval is presented for these data using the overall transformed mean of 0.620, and transforming the calculated limits back to the μg/g scale.

The variation between duplicate samples is estimated from the ANOVA table. The sampling and analysis mean square gives an estimated standard deviation of 0.184 in the transformed scale. This gives an exponentiated value of 1.202.

The means in the transformed scale for the smoking and non-smoking groups were 0.375 and 0.334, respectively. The t-statistic for the effect of smoking was 5.52, and again is significant beyond the 0.001 level. The difference between the two groups is estimated to be 0.058 μg/g average concentration.

FIGURE 16. LEAD CONCENTRATION IN LIVER vs AGE GROUP

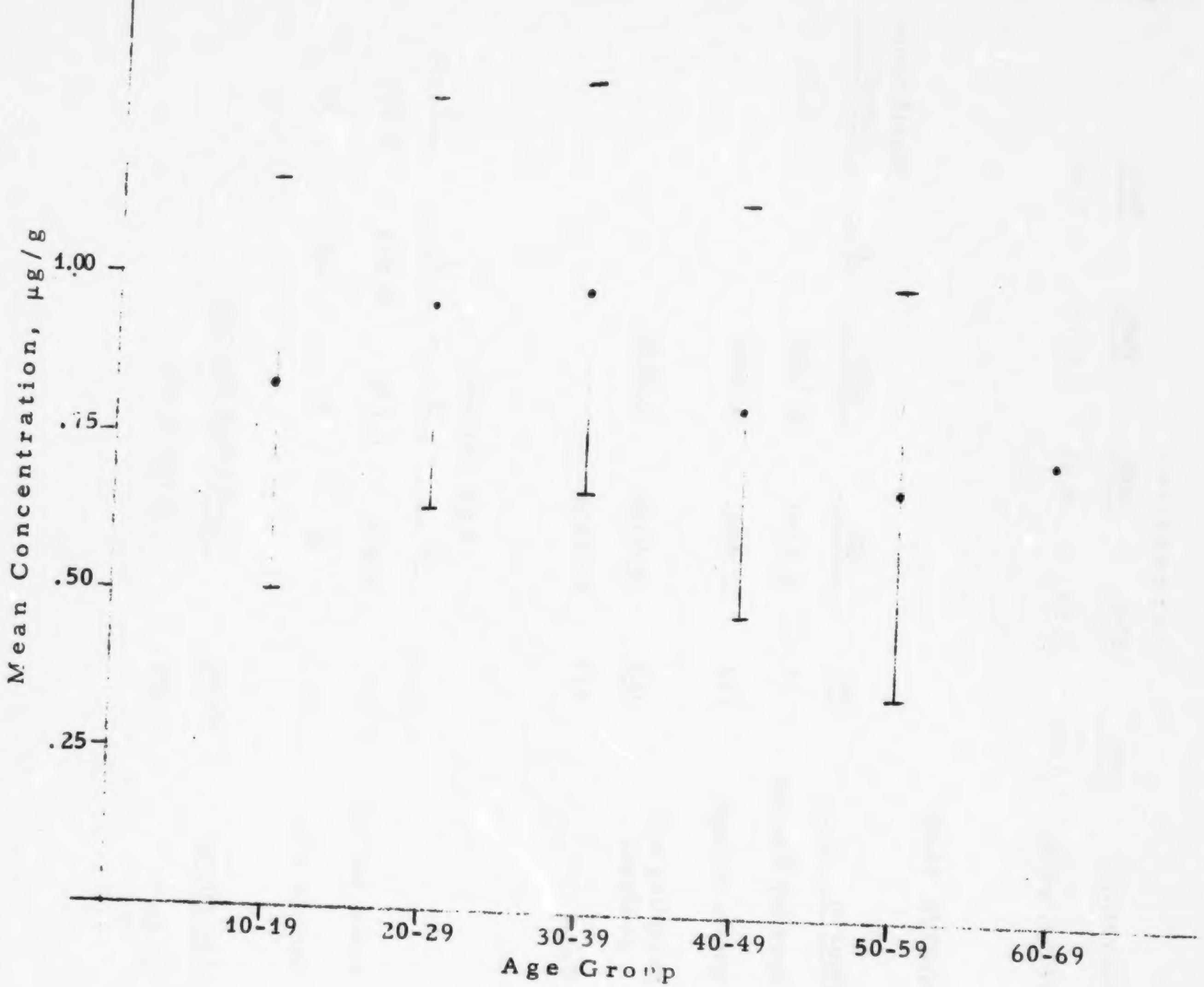


TABLE 17. STATISTICAL SUMMARY FOR LEAD IN LIVER TISSUE

	Percentiles				
Percentile	**5th**	**25th**	**50th**	**75th**	**95th**
Value, μg/g	0.25	0.53	0.81	1.17	1.91

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.6141	0.1226	1	N.S.
Within Groups	158	22.4921	0.1424		
Sampling and Analysis	164	0.5600	0.0034		
Total	327	23.6652			

	Age Group					
	1	2	3	4	5	6
Mean ln(1+x)	0.605	0.675	0.690	0.593	0.521	0.551
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.859	0.754-0.970

iii. Mercury

The Hg analyses are shown in Appendix I. The geometric means are plotted against age group and presented in Figure 17. The means for the first four groups are nearly equivalent, with a decrease in the 50-59 bracket. The high mean for 60-69 represents only one individual and is not necessarily indicative of the age group.

The statistical summary is shown in Table 18. The percentiles are calculated as before and give a median value of 0.059, with a range of 0.012 and 0.213 μg/g omitting the high values. The first and third quartiles are 0.035 and 0.098 μg/g, respectively.

The ANOVA table is used to evaluate age effects. The F-ratio for between age groups is less than one and no significant difference can be detected. From the means of the transformed data, no apparent trend exists in the data. There is little difference from age groups 1 to 4, with age group 5 somewhat lower.

The confidence interval for the population mean is calculated using the overall mean of 0.078 and the mean square for within groups. The 95-per cent confidence limits are from 0.066 to 0.097 μg/g.

The mean square for sampling and analysis gives an estimated standard deviation of 0.01, which implies good precision in the duplicate samples for Hg analysis.

The 116 smokers had an average concentration in the transformed scale of 0.077 compared to 0.080 for non-smokers. The resulting t-statistic was calculated as -0.64 and is clearly non-significant. As in the kidney tissue, no discernable effect of smoking on the Hg concentration was observed.

iv. Zinc

The analytical results for Zn in liver tissue are shown in Appendix H. The means for each age group are plotted in Figure 18. As can be seen, there is little difference among age groups with the exception of the single individual in the 60-69 group. The highest values are in the 20-39 groups, and then there is a tendency for a slight decrease over age.

FIGURE 17 MERCURY CONCENTRATIONS IN LIVER vs AGE GROUPS

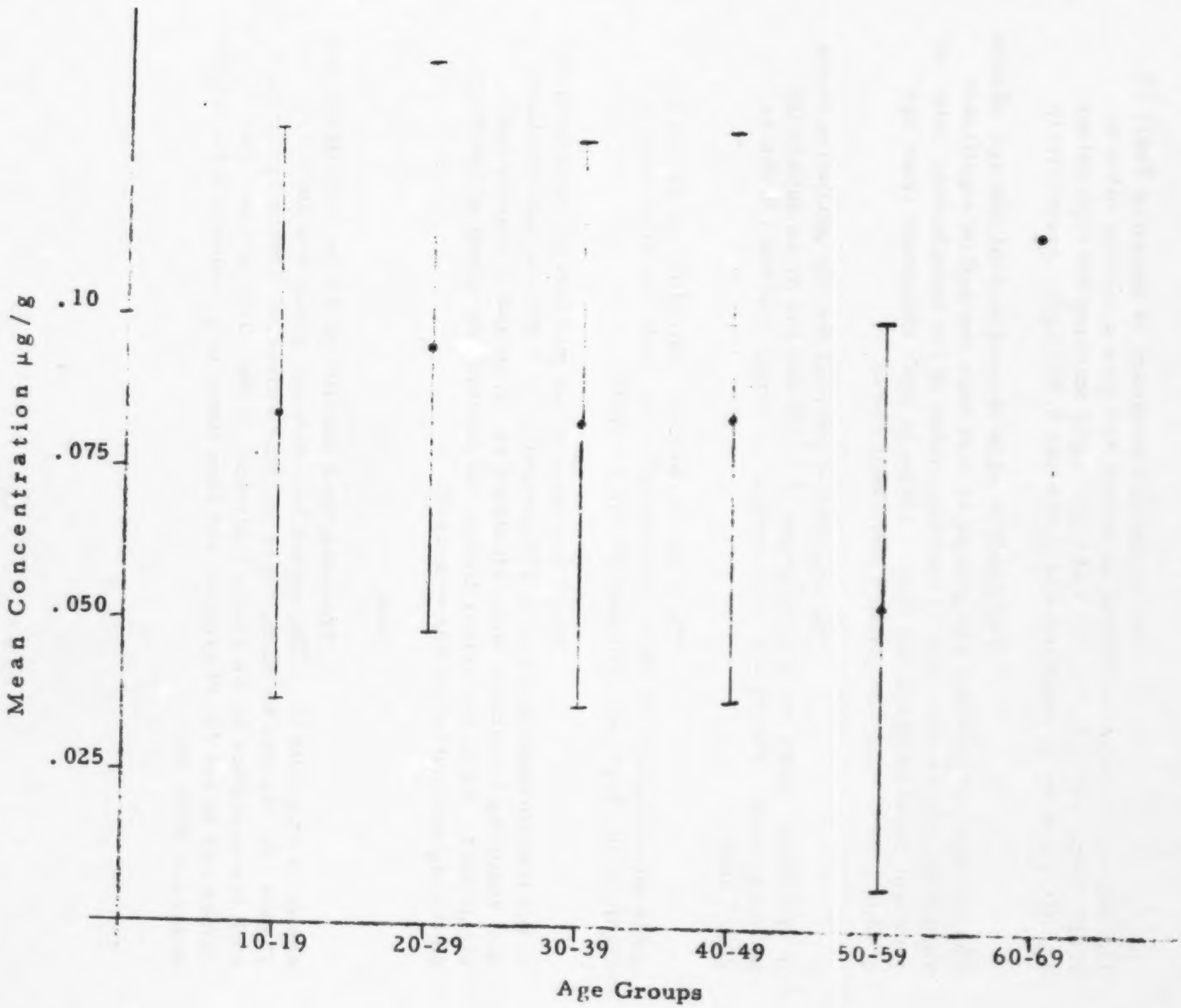


TABLE 18. STATISTICAL SUMMARY FOR MERCURY IN LIVER TISSUE

	Percentiles				
Percentile	5th	25th	50th	75th	95th
Value, μg/g	0.012	0.035	0.059	0.098	0.213

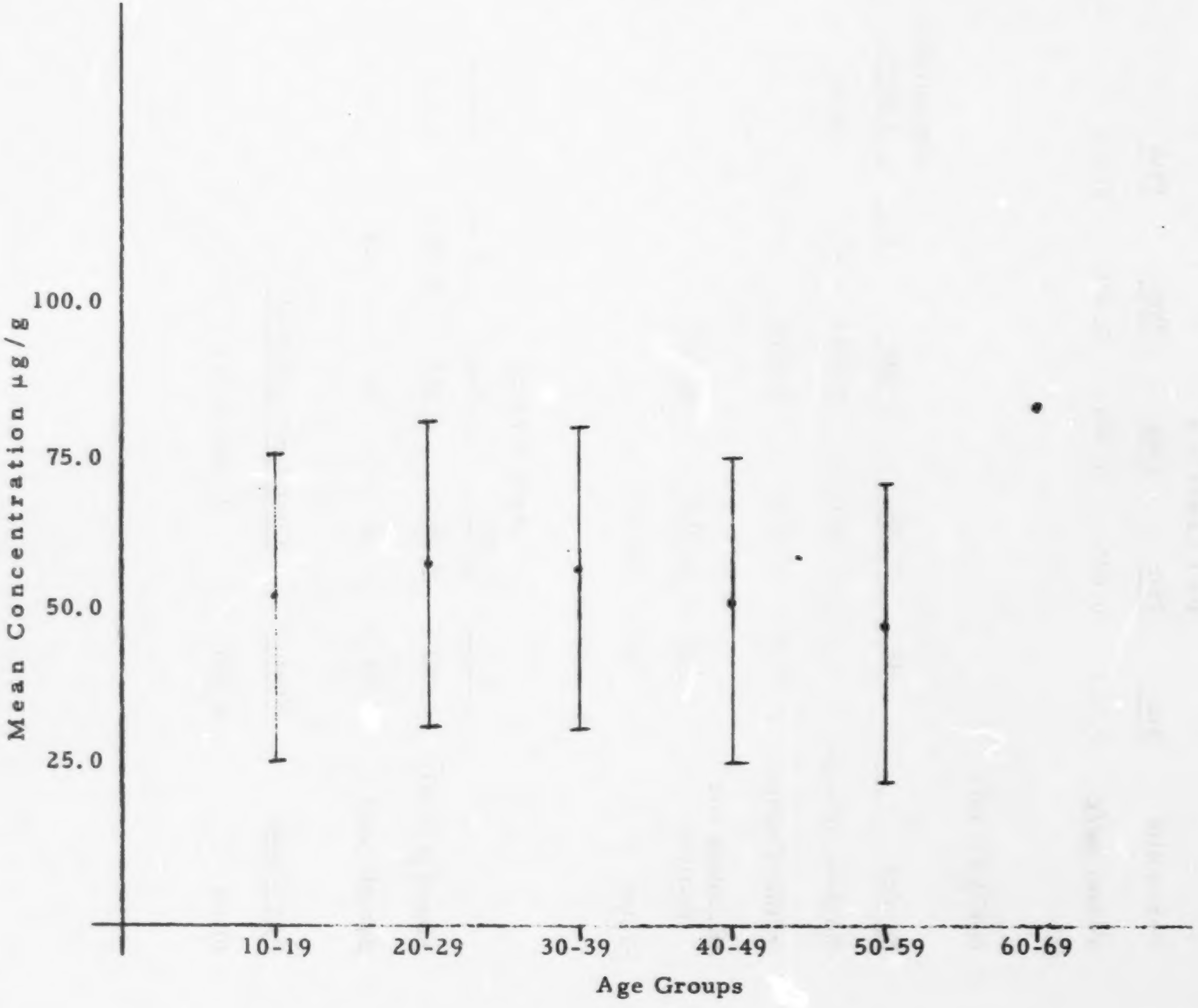
ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.0290	0.0058	<1	N.S.
Within Groups	158	1.3935	0.0088		
Sampling and Analysis	164	0.0169	0.0001		
Total	327	1.4394			

	Age Group					
	1	2	3	4	5	6
Mean [ln (1+x)]	0.081	0.091	0.080	0.081	0.052	0.109
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.081	0.066-0.097

FIGURE 18. ZINC CONCENTRATION IN LIVER vs AGE GROUP



The statistical summary is shown in Table 19. The percentiles of the distribution are estimated, and the median concentration is 55.28, with an expected range of 30.52 to 85.93 μg/g extreme values omitted. The middle 50 per cent of the data range from 44.65 to 68.92 μg/g.

The ANOVA table is used to evaluate the age differences. The F-ratio to test for significance of the age factor is less than one, and no differences can be detected between age groups. The means of the transformed data are shown, along with the sample sizes.

The overall mean of the transformed data, 4.01, is used to calculate a confidence interval for the population mean, and the estimated limits of a 95 per cent interval are from 51.42 to 59.15 μg/g.

The sampling and analysis component for these data gives an estimated standard deviation of 0.154 in the logarithmic scale. Taking the antilog gives 1.166, or 16.6 per cent variation between the duplicate samples.

The 116 smokers had an average concentration of 4.00 in the transformed scale versus 4.04 for the non-smokers. The t-statistic is calculated as 1.67, which does not exceed the tabled value at the 5 per cent level. The conclusion is, then, that no effect of smoking on concentration was evident in these data.

v. Summary of Liver Results

A summary of the findings in samples of liver tissue is shown in Table 20. The results of the effect of increasing age showed a similar pattern to the kidney data. There was an increase in Cd concentration to ages 40-49, while Pb values were highest in the 20-39 bracket. No age effects were noted in either Hg or Zn.

The effect of smoking cigarettes was to raise both Cd and Pb levels, but no difference was detectable in either the Hg or Zn levels.

TABLE 19. STATISTICAL SUMMARY FOR ZINC IN LIVER TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, µg/g	30.52	44.65	55.28	68.92	85.93

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.9275	0.1855	<1	N.S.
Within Groups	158	30.5073	0.1931		
Sampling and Analysis	164	3.8774	0.0236		
Total	327	35.3122			

Age Group

	1	2	3	4	5	6
Mean (ln x)	4.00	4.08	4.06	3.96	3.90	4.44
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	55.15	51.42-59.15

TABLE 20. SUMMARY OF RESULTS ON LIVER TISSUE

Metal	Age Effect	Linear Trend	Smoking Effect
Cadmium	Significant	Yes, levelling off at 40-49 group	Significant. Higher concentration among smokers
Lead	Not significant Highest in 20-39 groups	-	Significant. Higher concentration among smokers
Mercury	Not significant	-	Not significant
Zinc	Not significant	-	Not significant

c. Muscle

i. Cadmium

The analytical results for Cd in muscle tissue are shown in Appendix F. The means for the age groups are plotted in Figure 19, and show a strong tendency to increase with age. Through the 50-59 group, an increase is noted with no levelling off or decrease as was noted for Cd concentration in other tissues.

The statistical analyses are summarized in Table 21. The percentiles of the Cd concentration determined for the 164 cases collectively are shown. The median concentration is estimated to be 0.06 μg/g. The 5th to 95th percentiles have a range of 0.01 to 0.18 μg/g, while the middle 50 per cent range from 0.02 to 0.10 μg/g.

From the ANOVA table the age group factor has an F-ratio of 16.93, significant beyond the one per cent level. From the transformed mean values, the hypothesis of linear trend is tested using a Student's t-statistic. The calculated t is 8.68 with 158 df from the error term, which indicates that a strong tendency does exist for the means to increase with age.

Using the Within-Groups mean square from the ANOVA confidence intervals are calculated for each group and are presented in the summary statistics in Table 21.

The sampling and analysis variation is estimated from the bottom line of the ANOVA. The mean square within individuals is estimated to be 0.0002, which gives a standard deviation of 0.014 in the transformed scale. This implies good precision between the duplicate samples.

The transformed mean for the smokers was determined to be 0.072 as opposed to 0.052 for the non-smokers. The t-value for these data is 9.16, and again far exceeds the tabled values. The conclusion, then, is that for muscle as for the previous tissues, the smokers had higher observed concentrations. The estimated difference in average concentration between the two groups is 0.021 μg/g.

ii. Lead

The analytical results for Pb in muscle tissue are shown in Appendix G. The geometric means for the varying age groups are plotted in Figure 20. The age group 10-19 data are somewhat lower, then the next four groups are scattered.

FIGURE 19. CADMIUM CONCENTRATION IN MUSCLE vs AGE GROUP

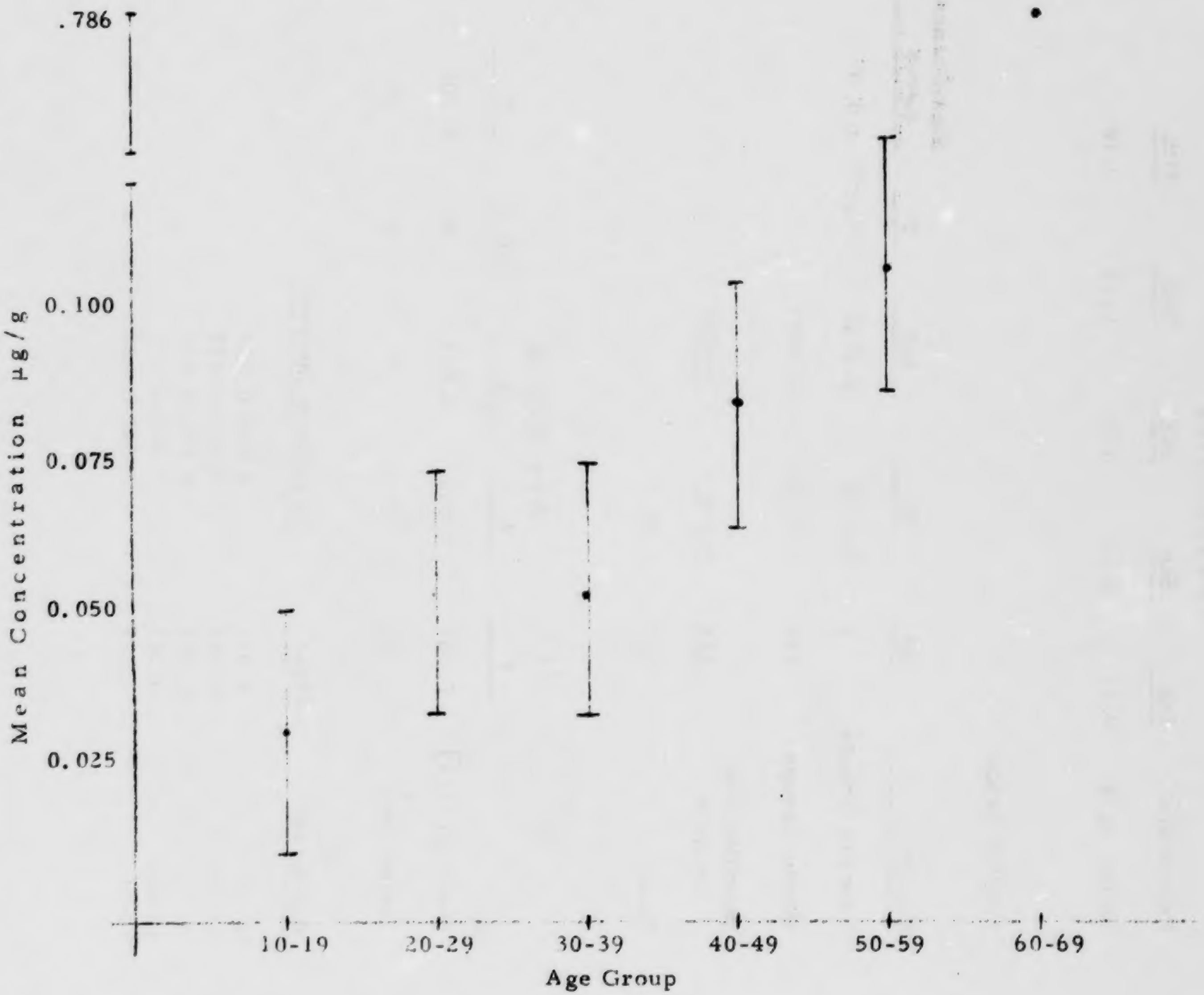


TABLE 21. STATISTICAL SUMMARY FOR CADMIUM IN MUSCLE TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, µg/g	0.01	0.02	0.06	0.10	0.18

ANOVA Table

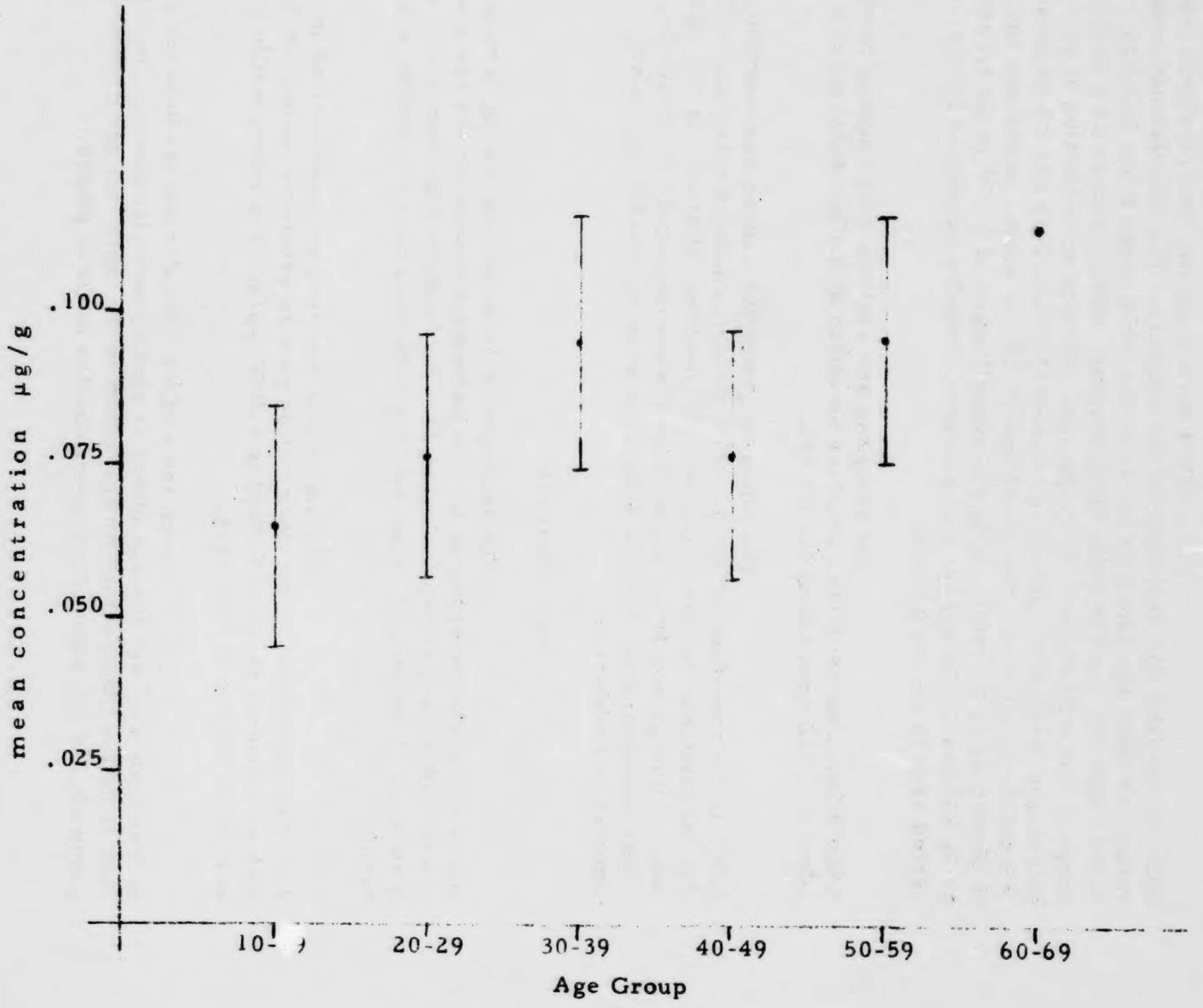
Source	df	SS	MS	F	Significance Level
Between Groups	5	0.3640	0.0728	16.93	< 0.01
Within Groups	158	0.6730	0.0043		
Sampling and Analysis	164	0.0263	0.0002		
Total	327	1.0633			

Age Group

	1	2	3	4	5	6
Mean $[\ln(1+x)]$	0.031	0.053	0.053	0.082	0.102	0.580
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-19	0.031	0.009-0.054
20-29	0.054	0.033-0.077
30-39	0.054	0.031-0.078
40-49	0.085	0.060-0.112
50-59	0.107	0.082-0.133

FIGURE 20. LEAD CONCENTRATION IN MUSCLE TISSUE vs AGE GROUP



For the muscle tissue, the summary of the statistical analyses is contained in Table 22. The percentiles of the distribution show a median value of 0.066 µg/g, with an expected range of 0.033 to 0.232 µg/g. The middle 50 per cent of the concentration range from 0.049 to 0.091.

The ANOVA table indicates that no significant differences exist due to the age of the subjects. The transformed mean values for each age group as shown in the table range from 0.063 to 0.092, with the one 60+ individuals omitted, which represents a narrow range of concentrations. By inspection, there is no indication of an increasing trend with age due to the fact that the 20-29 and 40-49 means are nearly equal as are the 30-39 and 50-59. A single confidence interval is presented as a result, using the overall mean of 0.079 in the transformed scale and the within groups mean square, with the calculated limits converted back to the µg/g scale.

The sampling and analysis mean square from the ANOVA gives an estimated standard deviation of 0.022, which gives a value of 1.022 upon taking the antilog.

The smoking group had a mean concentration of 0.081 in the transformed scale, while the non-smokers mean was 0.075. The test statistic for these data is 1.45, and the difference is not significant. Although somewhat higher levels were observed for the smokers, it was insufficient to detect a difference when the variability among samples is considered.

iii. Mercury

The analytical determinations for Hg in muscle tissue are shown in Appendix I. The geometric means for the age groups are calculated and shown in Figure 21. No difference is observed in these from ages 10 through 59, with only the individual over 60 showing a higher result.

The statistical analyses are summarized in Table 23. The percentiles of the distribution give an estimated median of 0.0015, with an expected range of 0.0005 to 0.0047 µg/g. The interquartile range is from 0.0010 to 0.0023 µg/g.

From the ANOVA, the F-ratio for between groups is less than one, and the age factor is clearly non-significant. As can be seen from the transformed means shown in the table, all age groups except group six had the same mean concentration to three places.

TABLE 22. STATISTICAL SUMMARY FOR LEAD IN MUSCLE TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, µg/g	0.033	0.049	0.066	0.091	0.232

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.0207	0.0041	< 1	N.S.
Within Groups	158	1.4397	0.0091		
Sampling and Analysis	164	0.0753	0.0005		
Total	327	1.5357			

	Age Group					
	1	2	3	4	5	6
Mean $\left[\ln(1+x)\right]$	0.063	0.074	0.091	0.075	0.092	0.108
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.082	0.066-0.099

FIGURE 21. MERCURY CONCENTRATION IN MUSCLE TISSUE vs AGE GROUP

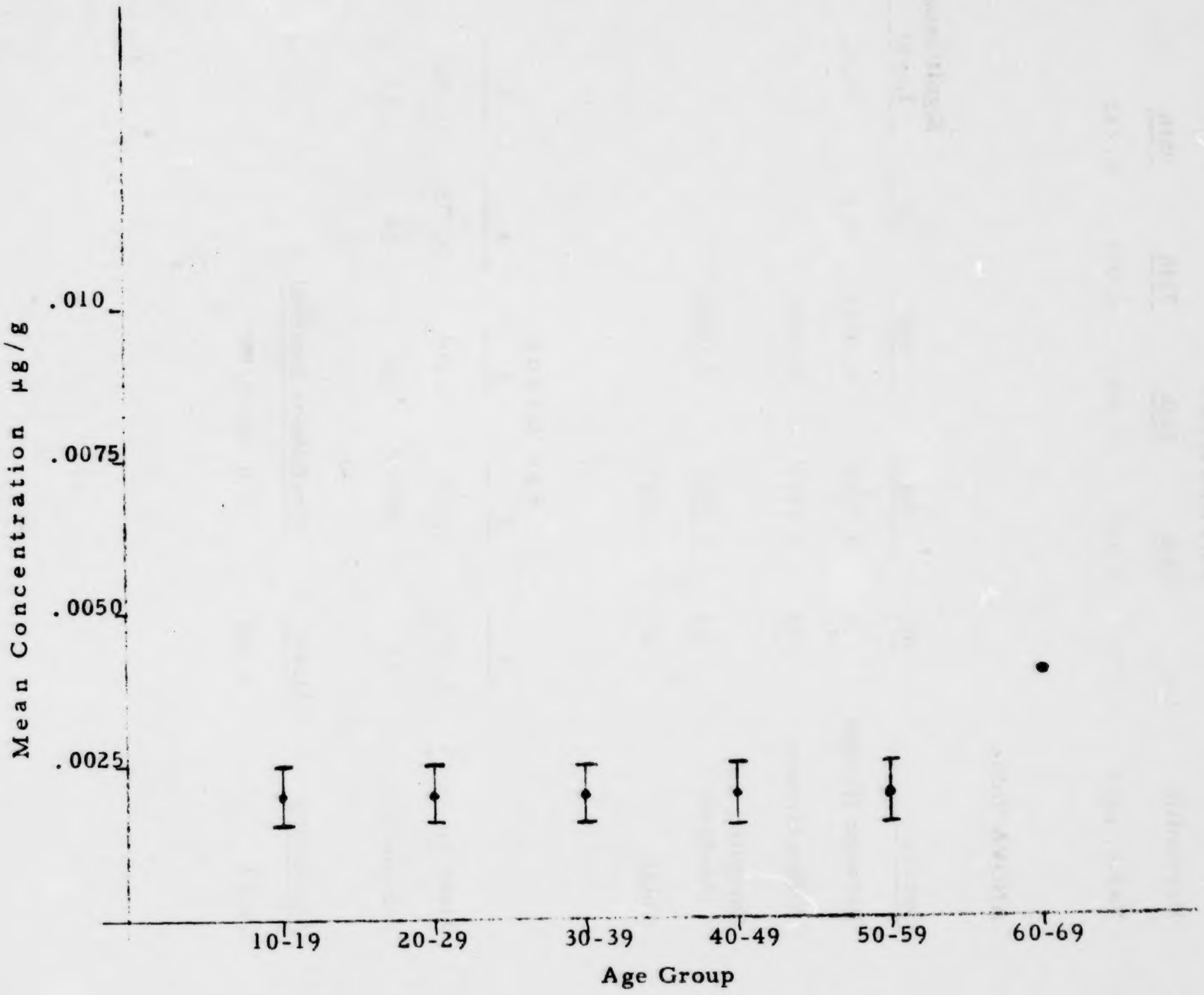


TABLE 23. STATISTICAL SUMMARY FOR MERCURY IN MUSCLE TISSUE

	Percentiles				
Percentile	5th	25th	50th	75th	95th
Value, μg/g	0.0005	0.0010	0.0015	0.0023	0.0047

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.0000	0.00000	0.00	N.S.
Within Groups	158	0.0018	0.00001		
Sampling and Analysis	164	0.0001	0.00000		
Total	327	0.0019			

	Age Group					
	1	2	3	4	5	6
Mean [ln(1+x)]	0.002	0.002	0.002	0.002	0.002	0.004
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.0020	0.0015-0.0025

The confidence interval for the true mean of the population is calculated using the overall mean of 0.0020 and the within groups mean square. The 95 per cent limits are 0.0015 and 0.0025 μg/g.

The sums of squares for sampling and analysis was negligible for these data, and good precision was obtained between duplicate samples for the Hg determination.

The smoking group had a mean transformed value of 0.0021 compared to a mean of 0.0018 for the non-smokers. The t-statistic for these data is 0.14 and is clearly not significant. Thus, no effect of smoking on the concentration of Hg in muscle tissue could be observed.

iv. Zinc

The analytical results for Zn in muscle tissue are shown in Appendix H. The geometric means are plotted for the age groups in Figure 22 and show a similar pattern to previous data. The highest results are in the 20-39 group, and there is a slight decreasing trend after that point.

The summary of the statistical analyses on the determined concentrations of Zn in muscle tissue is shown in Table 24.

The percentiles of the distribution are estimated and yield a median value of 99.71 μg/g. The range of the middle 90 per-cent of the data is from 54.07 to 139.80 μg/g, while the interquartile range is from 84.8 to 113.01.

From the ANOVA, the F-ratio for between groups is less than one and the age group factor is determined to be nonsignificant. The transformed means differ by 0.09 or less, with the exception of the 60+ individual.

Using the overall mean of 4.55 in the transformed scale, a 95 per cent confidence level is calculated as 88.21 to 99.38 μg/g for the true mean of the population under study.

The sampling and analysis standard deviation is 0.154 in the transformed scale. Exponentiating gives 1.166

The smoking group had a mean transformed concentration of 4.55 as did the non-smoking group. As a result, the t-statistic has a value of zero and no significant difference exists between the two groups.

FIGURE 22. ZINC CONCENTRATION IN MUSCLE TISSUE vs AGE GROUP

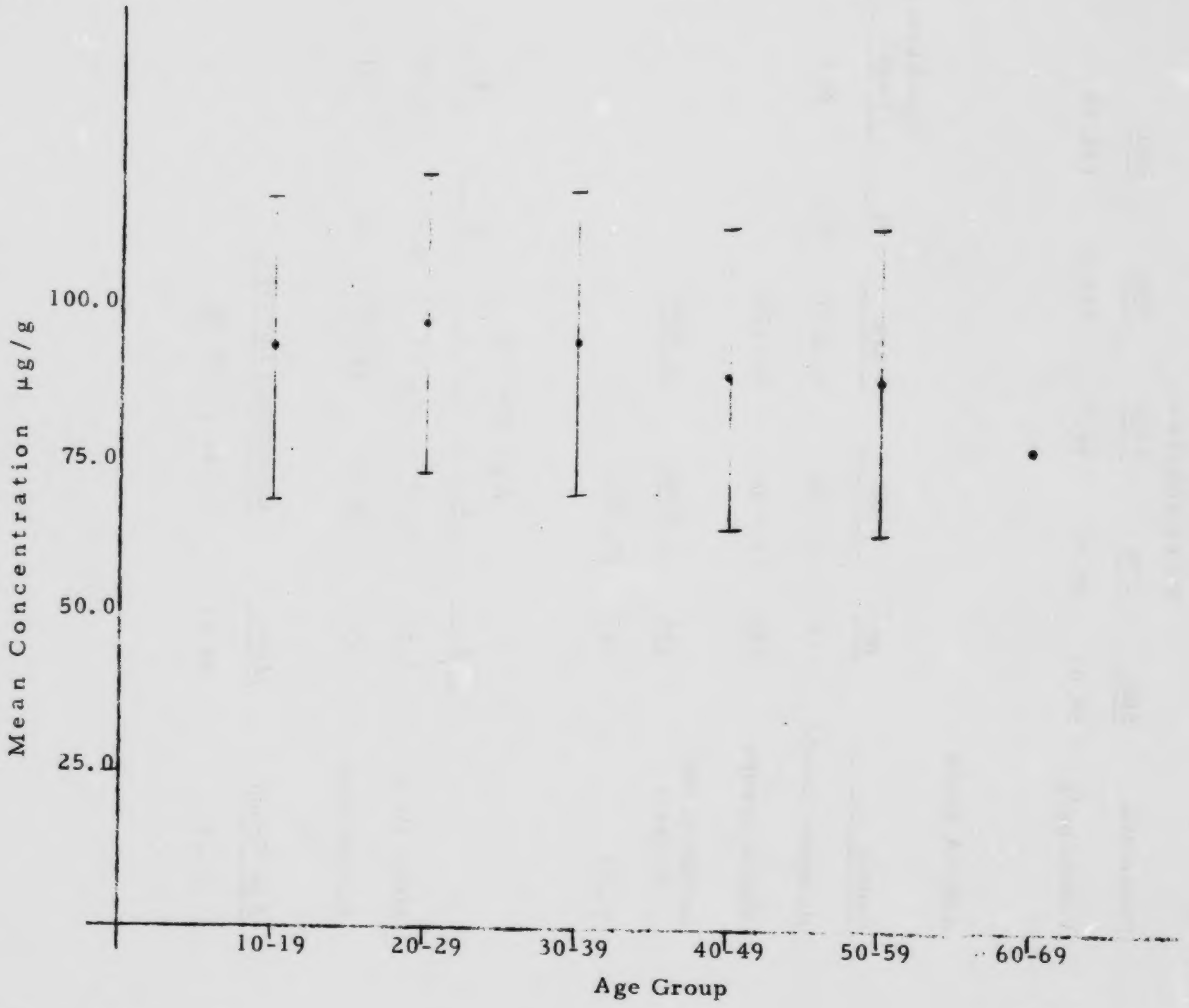


TABLE 24. STATISTICAL SUMMARY FOR ZINC IN MUSCLE TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, μg/g	54.07	84.80	99.71	113.01	138.80

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.1194	0.0239	< 1	N.S.
Within Groups	158	23.3104	0.1475		
Sampling and Analysis	164	3.8744	0.0236		
Total	327	27.3042			

	Age Group					
	1	2	3	4	5	6
Mean (ln x)	4.55	4.59	4.57	4.51	4.50	4.37
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	94.63	88.21-99.38

v. Summary of Muscle Results

The results of the investigations on muscle tissue follow a similar pattern to the liver tissue, and are summarized in Table 25. There was no discernable age tendency except for Cd data. For these results, the increase with the age of the subject was observed, and a linear trend detected through all age groups.

The smokers showed significantly higher levels of Cd and higher, though insignificant, levels of Pb than the non-smokers. There were no differences between the groups for the remaining two metals studied.

d. Pancreas

i. Cadmium

The analytical results for Cd in pancreas tissue are shown in Appendix F. The geometric means for the age groups are plotted in Figure 23 and show a similar pattern to previous Cd results. The average concentration increases through the 40-49 group, then levels off.

The statistical summary is shown in Table 26. Percentiles relating to the 164 individuals are used to summarize the distributional pattern of the observed concentrations. The median is estimated to be 0.52 μg/g, with a normal range of 0.18 to 1.28, and an interquartile range of 0.40 μg/g (0.33 to 0.73). The geometric mean for all the observations is 0.557 μg/g, which indicates good agreement between the two sets of statistics.

The results of the ANOVA on the Cd concentrations in pancreas tissue are also shown in Table 26. The F-ratio for between groups is calculated to be 9.20, which is again significant beyond the one per cent level. Using the transformed means as shown, the hypothesis of a linear trend is tested, and the resultant t-statistic is calculated to be 5.32. Since this far exceeds the tabled value at the one per cent level, the tendency to increase with age is again strong.

Since an age group dependency exists, separate confidence intervals are calculated for each age group and presented in Table 26. The within age group is used for the error term, and the limits are then translated back to μg/g for the table.

From the sampling and analysis component the variability between duplicate samples is estimated. The standard deviation is estimated as 0.032 in the transformed scale which gives 1.033 when exponentiated.

TABLE 25. SUMMARY OF RESULTS ON MUSCLE TISSUE

Metal	Age Effect	Linear Trend	Smoking Effect
Cadmium	Significant	Yes	Significant, higher concentration among smokers
Lead	Not Significant	-	Not significant, but higher among smokers
Mercury	Not Significant	-	Not significant
Zinc	Not Significant	-	Not Significant (no difference)

FIGURE 23. CADMIUM CONCENTRATION IN PANCREAS vs AGE GROUP

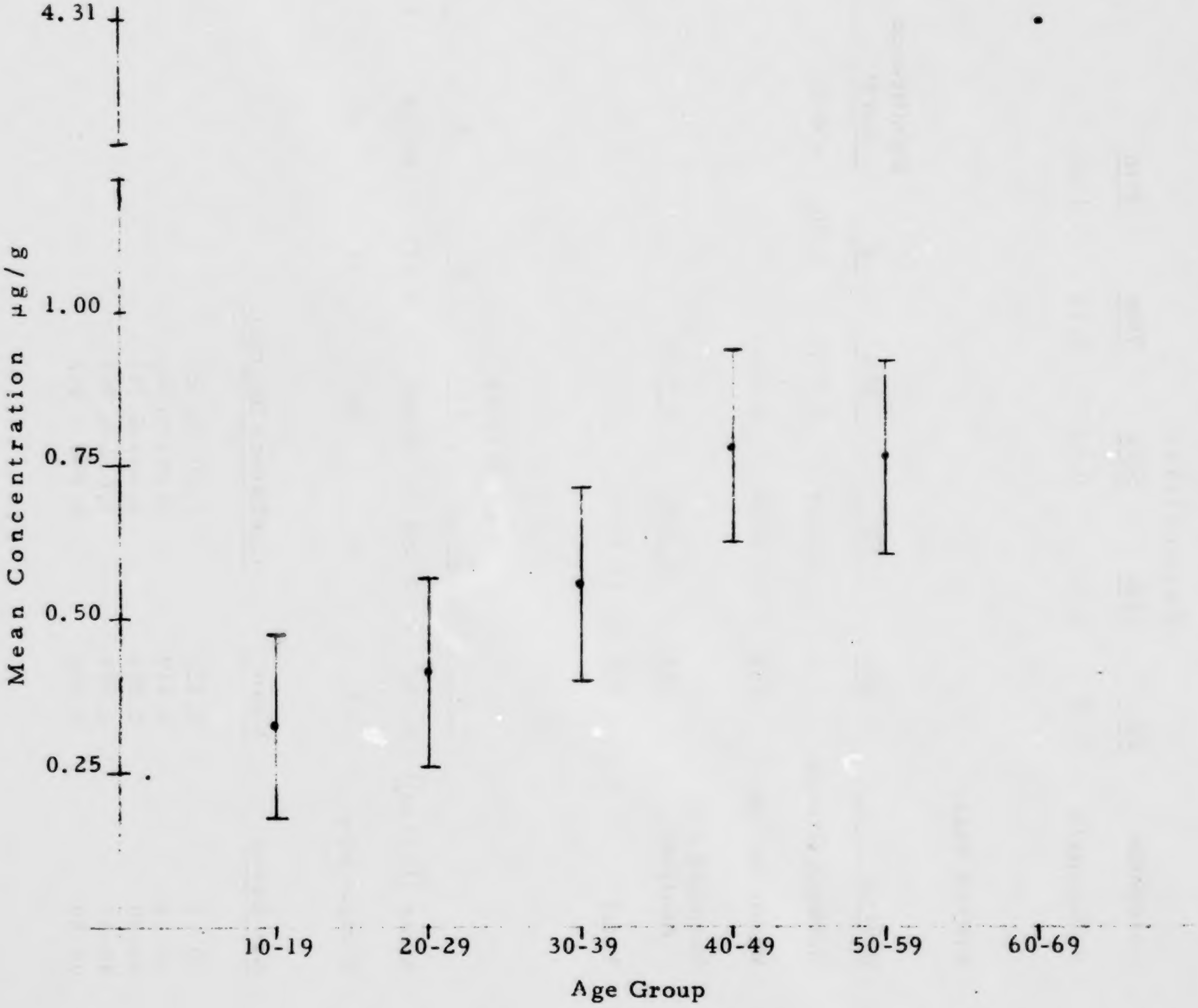


TABLE 26. STATISTICAL SUMMARY FOR CADMIUM IN PANCREAS TISSUE

	Percentiles				
Percentile	**5th**	**25th**	**50th**	**75th**	**95th**
Value, μg/g	0.18	0.33	0.52	0.73	1.28

ANOVA Table

Source	**df**	**SS**	**MS**	**F**	**Significance Level**
Between Groups	5	3.6848	0.7370	9.20	<0.01
Within Groups	158	12.6536	0.0801		
Sampling and Analysis	164	0.1686	0.0010		
Total	327	16.5070			

	Age Group					
	1	2	3	4	5	6
Mean [ln (1+x)]	0.282	0.350	0.440	0.577	0.569	1.670
Sample size	33	38	33	31	28	1

Age Group	**Mean**	**Confidence Interval**
10-19	0.326	0.203-0.461
20-29	0.419	0.297-0.553
30-39	0.553	0.409-0.711
40-49	0.781	0.611-0.968
50-59	0.766	0.590-0.962

The 116 smokers had a mean value, in the transformed scale, of 0.476 compared to 0.363 for the non-smokers. This results in a t-value of 20.76 and once again an extremely significant result is observed in the Cd data. The difference between the means is estimated as 0.172 µg/g.

ii. Lead

The analytical results for Pb in pancreas tissue are shown in Appendix G. The geometric means for the age groups are plotted and presented in Figure 24. The highest values are observed in the 20-29 age groups, with a slight decreasing trend after that.

The statistical summary is shown in Table 27. The percentiles of the distribution are estimated and give a median of 0.40 µg/g, with a normal range of 0.18 to 0.96 omitting extreme values. The interquartile range is estimated as 0.24 µg/g, from 0.30 to 0.54.

The ANOVA is summarized in the table along with the transformed means. As in the previous tissues, no significant age group effect is noted. The tendency in the mean values in pancreas tissue for a slight decrease over age is not significant when the within group variability is considered.

The overall mean in the transformed scale is 0.363, which gives a confidence interval of 0.392 to 0.484 µg/g, using the mean square for within groups for the calculation.

The variation attributable to duplicate samples is estimated from the sampling and analytical component of the ANOVA table. The estimated transformed standard deviation is 0.044, which gives 1.045, which is a relatively precise determination.

The 116 smokers had a mean concentration in the transformed scale of 0.426 versus 0.409 for the non-smokers. The resultant t-statistic is 2.03, which has a significance level of approximately 0.05. The conclusion is, then, that significantly higher concentrations of Pb were observed among the smoking group. The difference between the two groups is estimated to be 0.026 µg/g average concentration.

FIGURE 24. LEAD CONCENTRATION IN PANCREAS TISSUE vs AGE GROUP

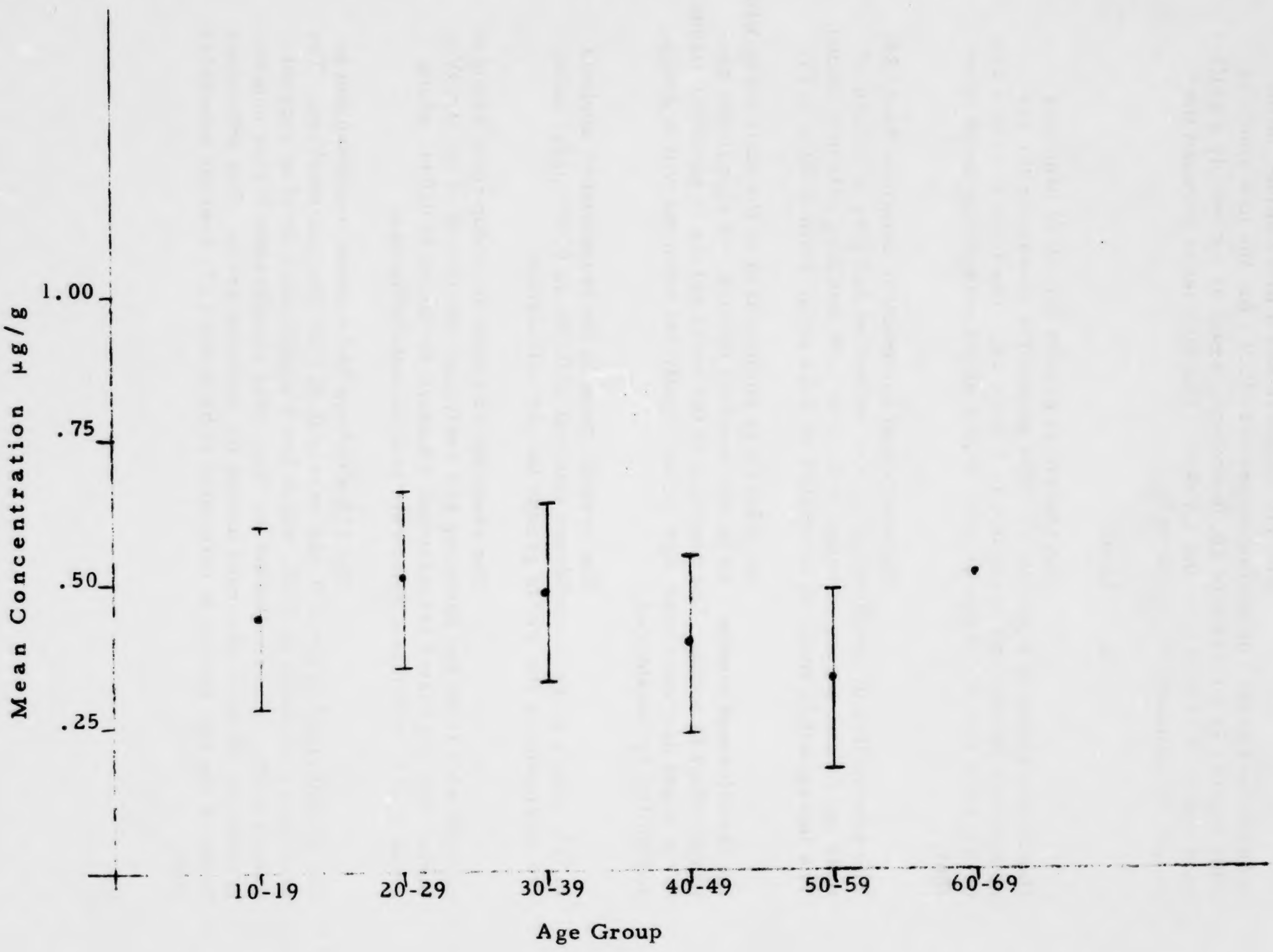


TABLE 27. STATISTICAL SUMMARY FOR LEAD IN PANCREAS TISSUE

Percentile	Percentiles 5th	25th	50th	75th	95th
Value, µg/g	0.18	0.30	0.40	0.54	0.96

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.1194	0.0239	< 1	N.S.
Within Groups	158	7.0930	0.0449		
Sampling and Analysis	164	0.3187	0.0019		
Total	327	7.5311			

	Age Group 1	2	3	4	5	6
Mean [ln (1+x)]	0.369	0.415	0.391	0.335	0.287	0.264
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.438	0.392-0.484

iii. Mercury

The analytical determinations for Hg in pancreas tissue are shown in Appendix I. The geometric means for the tables are used to plot concentration versus age and are presented in Figure 25. The highest concentration was observed in the 20-29 group, but all age groups have similar means.

The statistical summary is shown as Table 28. Percentiles are calculated for the distribution using the mean concentrations for the 164 individuals. The median is estimated to be 0.009 μg/g, with a range of 0.0029 to 0.0281 from the 5th to 95th percentiles. The range of the middle 50 per cent of the data is from 0.0057 to 0.0141.

The ANOVA table shows an F-ratio for between groups of less than one and the conclusion is that there is no tendency for Hg concentration to differ according to age. From the means of the transformed data, there is no visible tendency toward increasing or decreasing concentration with age.

The overall mean of the transformed data, 0.011, is used with the within group mean square to estimate the limits of a 95-per cent confidence interval on the true mean of the population under study. The calculated interval is from 0.009 to 0.013 μg/g.

The sampling and analysis sums of squares is again negligible for these concentrations. The variability between analytical determinations on duplicate samples is small.

The transformed mean of the smoking group is 0.0114 versus 0.0105 for the non-smoking group. The calculated t for these data is 6.48, which exceeds the tabled value at the 0.1-per cent level. The difference is significant, then, and the average difference is estimated to be 0.0004 μg/g.

iv. Zinc

The results of the analyses on pancreas tissue for Zn content are shown in Appendix H. The geometric means are plotted by age group in Figure 26. These tend to rise gently with age until the 40-49 group, then to level off for the 50-59 group.

FIGURE 25. MERCURY CONCENTRATION IN PANCREAS TISSUE vs AGE GROUP

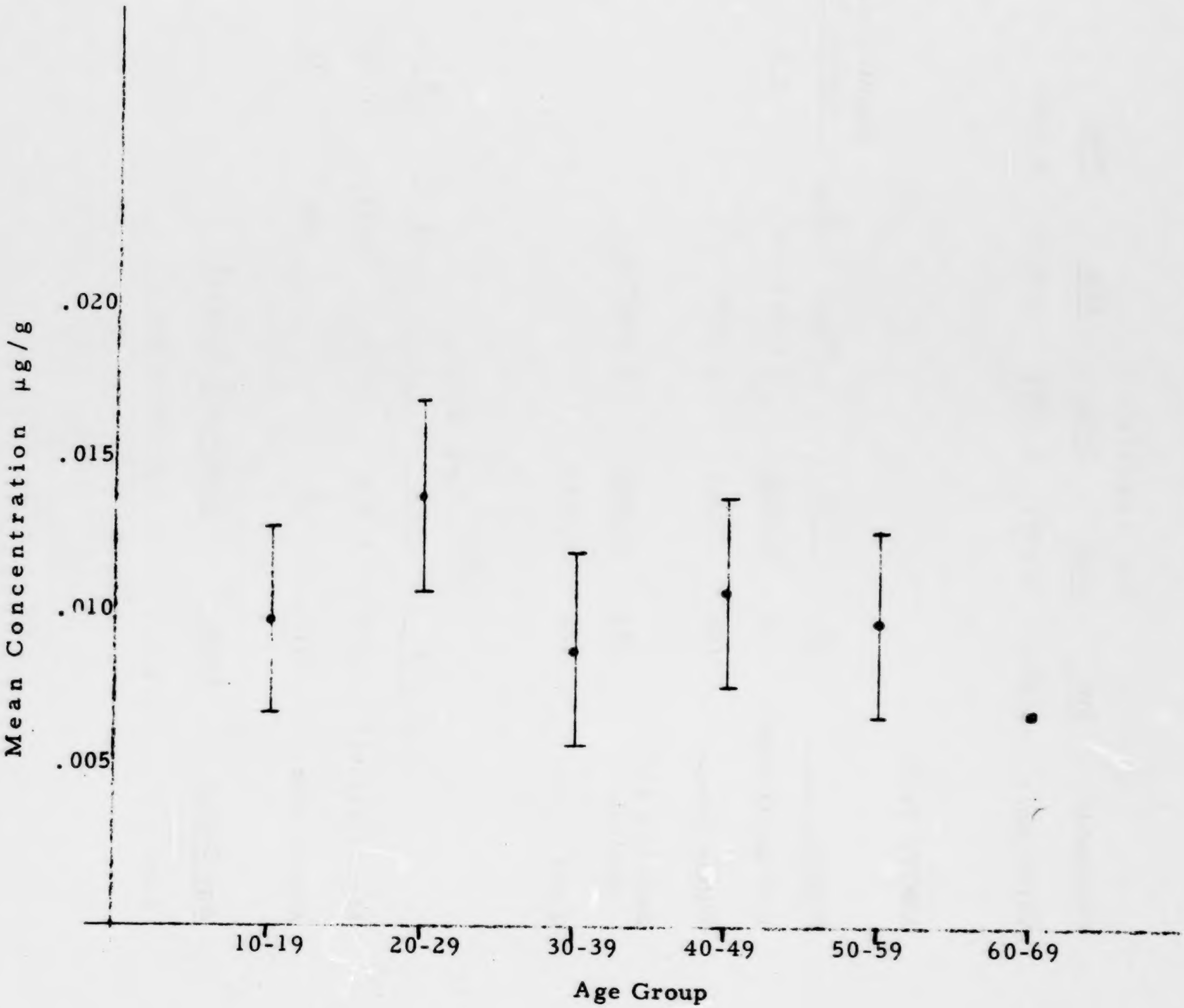


TABLE 28. STATISTICAL SUMMARY FOR MERCURY IN PANCREAS TISSUE

	Percentiles				
Percentile	**5th**	**25th**	**50th**	**75th**	**95th**
Value, µg/g	0.0029	0.0057	0.0090	0.0141	0.0281

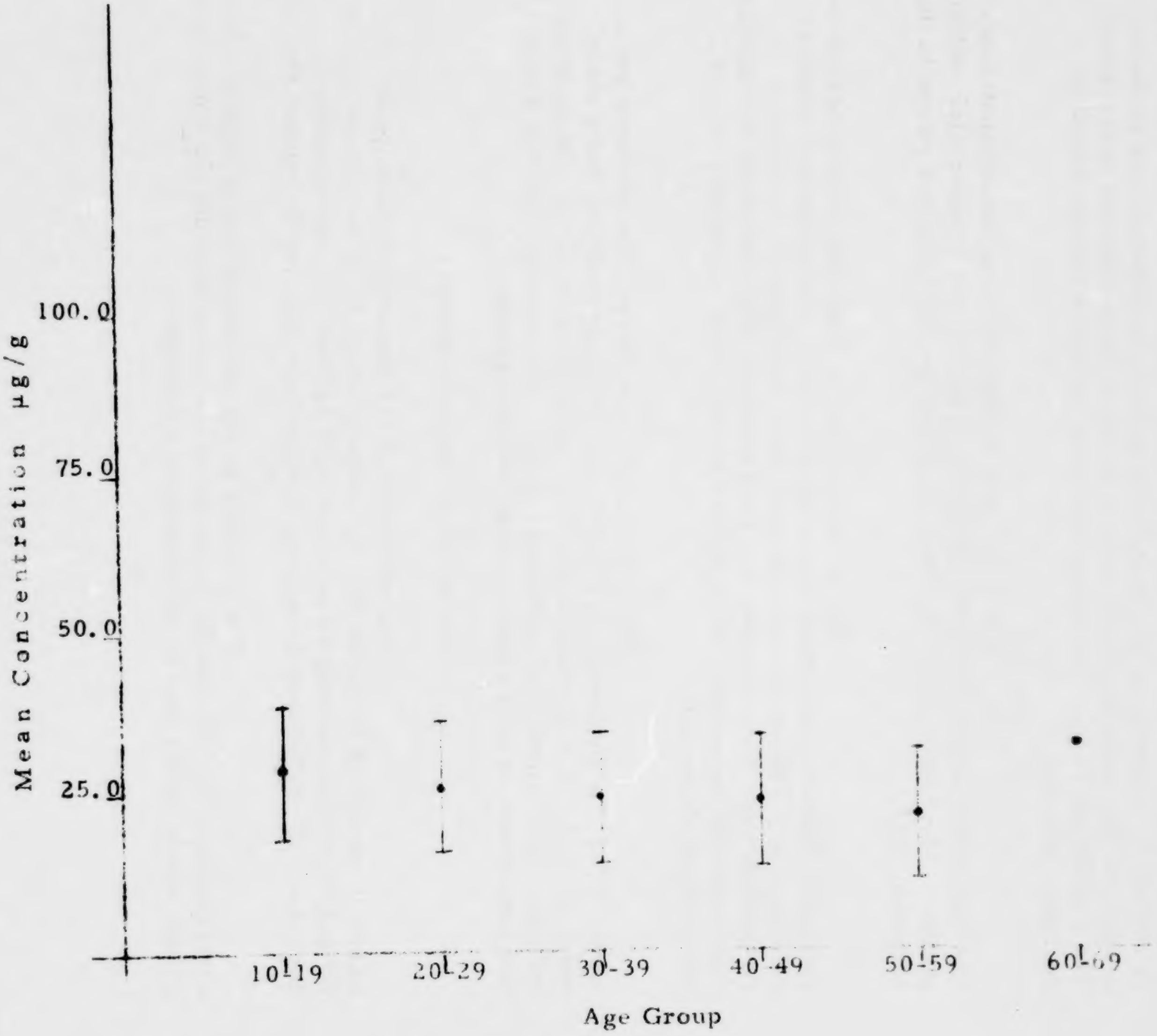
ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.0006	0.00012	< 1	N.S.
Within Groups	158	0.0261	0.00017		
Sampling and Analysis	164	0.0002	0.0000012		
Total	327	0.0269			

	Age Group					
	1	2	3	4	5	6
Mean $\boxed{\ln(1+x)}$	0.010	0.014	0.009	0.011	0.010	0.007
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.011	0.009-0.013

FIGURE 26. ZINC CONCENTRATION IN PANCREAS TISSUE vs AGE GROUP



The statistical analyses are summarized in Table 29. The percentiles are calculated using the complete set of concentration determinations. The median is estimated as 25.22 μg/g, with a normal range of 16.29 to 37.38 μg/g, omitting extreme values. The middle 50 per cent of the concentrations ranged from 21.98 to 27.92 μg/g.

The age factor is significant for the concentration of Zn, since the F-ratio is significant at the 5 per cent level. The contrast for linear trend gives a t-statistic of -3.26, when the mean for group six is excluded. This value would unfairly impact the contrast and is disregarded for the trend analysis since it is based upon only one observation. The conclusion is that the concentration of Zn in the kidney tended to decrease with age.

Since age was significant, a separate confidence interval is calculated for each age group using the mean square for within groups. The 95-per cent level was used and the intervals are shown in the summary table.

The variability due to duplicate determinations is estimated from the sampling and analysis term. The estimated standard deviation is 0.140 for the transformed data, which gives 1.150 upon exponentiating. This implies that the variability between duplicate samples due to sample-to-sample differences and analytical variability was 15.0 per cent for these data.

For zinc in pancreas tissue, the smokers had a mean of 3.21 in the transformed scale and the non-smokers had a mean value of 3.24. The t-statistic for this comparison is -1.12, and does not indicate that a significant difference exists. As a result, the two groups are considered to have equal average concentrations.

v. Summary of Pancreas Results

The summary of the investigations on pancreas tissue is contained in Table 30. Age effects were noted for Cd and Zn, with Cd concentration showing an increase with age and Zn concentration a decrease. No difference among age groups was detected for either Pb or Hg.

The smoking group had significantly higher concentrations of Cd, Pb and Hg in the pancreas tissue than did the non-smoking group, but no difference in Zn content was detected.

TABLE 29. STATISTICAL SUMMARY FOR ZINC IN PANCREAS TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, μg/g	16.29	21.98	25.22	27.92	37.38

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	1.5108	0.3022	2.57	< 0.05
Within Groups	158	18.5870	0.1176		
Sampling and Analysis	164	3.1969	0.0195		
Total	327	23.2947			

	Age Group					
	1	2	3	4	5	6
Mean (ln x)	3.366	3.238	3.214	3.171	3.074	3.478
Sample size	33	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-19	28.962	24.765-31.557
20-29	25.483	21.851-27.417
30-39	24.878	21.131-26.966
40-49	23.831	19.989-26.058
50-59	21.628	18.163-23.410

TABLE 30. SUMMARY OF RESULTS ON PANCREAS TISSUE

Metal	Age Effect	Linear Trend	Smoking Effect
Cadmium	Significant	Yes, increasing with age.	Significant. Higher concentrations in smokers.
Lead	Not significant	-	Significant. Higher concentrations in smokers.
Mercury	Not significant	-	Not significant
Zinc	Significant	Yes, decreasing with age.	Significant. Higher concentrations in smokers.

e. Fat

i. Cadmium

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The results of the Cd analyses on fat tissue are shown in Appendix F. Only 98 of the autopsy cases were used and one of these was analyzed only in a single determination. The geometric means for the age groups are plotted in Figure 27. As can be seen, the means rise up to age group 40-49, then decrease slightly. The value for group six is based on one individual and not considered representative.

The statistical summary is shown in Table 31. The percentiles are calculated as before and show a median of 0.039 µg/g with an expected range of 0.05 to 0.112 µg/g, excluding the upper and lower five per cent of the distribution. The interquartile range is 0.049 (0.065-0.016) where the middle 50 per cent of the concentrations fall.

From the ANOVA table, the F-ratio testing significance of the age group factor is 25.21, which is clearly significant. The transformed means indicate a linear trend does exist, and the contrast is again tested. The t-statistic for the linear hypothesis is calculated to be 1.775 which indicates a linear component does exist at a significance level of about seven per cent, and that there is a tendency to increase with age.

Since the age group factor is significant, the means for each age group are used to calculate confidence intervals on the true mean concentration for each age group, and these are displayed in the table.

The sampling and analysis component of the determinations in fat is calculated from the ANOVA. The mean square for sampling and analysis is 0.0012, which gives a standard deviation of 0.035 in the transformed scale. Exponentiating gives a value of 1.036, which implies 3.6 per cent variation in the results due to duplicate samples and analytical variation.

The effect of smoking on Cd in fat tissue is evaluated using the transformed means of 0.054 for the smokers and 0.029 for the non-smokers. The t-statistic was calculated as 3.05, which exceeds the 0.1-per cent level. The conclusion is, then, that the smokers had higher concentrations of Cd in their fat tissue than the non-smokers. The estimated difference is 0.026 µg/g average concentration between the two groups.

FIGURE 27. CADMIUM CONCENTRATION IN FAT TISSUE vs AGE GROUP

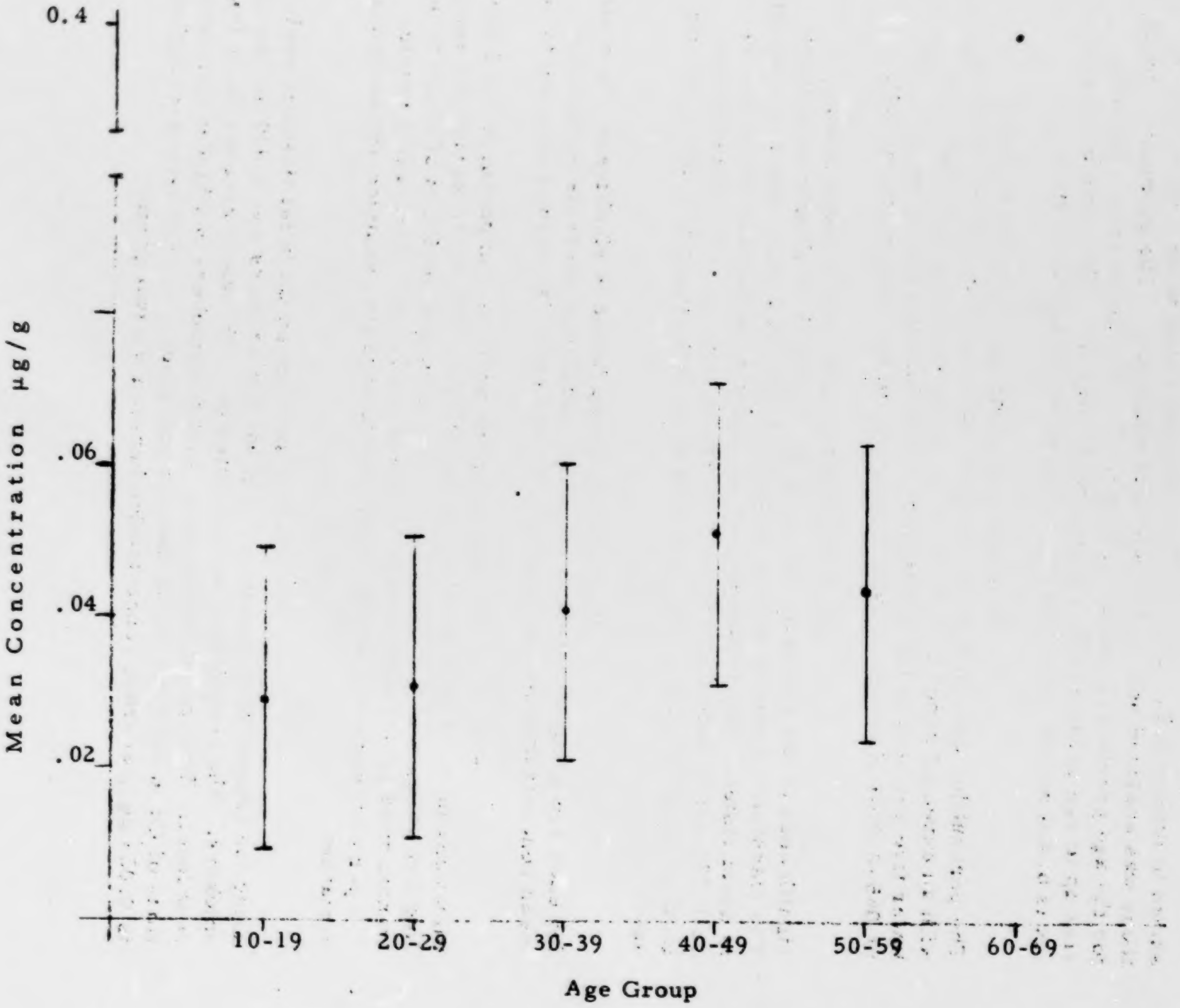

TABLE 31. STATISTICAL SUMMARY FOR CADMIUM IN FAT TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, μg/g	0.005	0.016	0.039	0.065	0.112

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.1764	0.0353	25.21	<0.01
Within Groups	92	0.1283	0.0014		
Sampling and Analysis	97	0.1194	0.0012		
Total	194	0.4241			

	Age Group					
	1	2	3	4	5	6
Mean [ln(1+x)]	0.0284	0.0307	0.0403	0.0504	0.0434	0.3269
Sample size	17	22	24	16	18	1

Age Group	Mean	Confidence Interval
10-19	0.0288	0.0107-0.0473
20-29	0.0312	0.0152-0.0474
30-39	0.0411	0.0256-0.0569
40-49	0.0517	0.0326-0.0711
50-59	0.0444	0.0264-0.0626

ii. Lead

The analytical results for Pb in fat tissue are shown in Appendix G. Tissues from 98 subjects were analyzed for Pb, all but one in duplicate. The geometric means of the age groups were plotted and are presented in Figure 28. As can be seen, there is little difference among the results with the exception of the individual in the 60-69 group.

The summary of the statistical analyses is shown in Table 32. The percentiles of the distribution are presented in the table and a median concentration of 0.141 is estimated from the 164 cases. The interquartile range is from 0.061 to 0.293 µg/g, while the range of the middle 90 per cent of the data was from 0.012 to 0.686 µg/g.

The ANOVA yields an F-ratio of less than one for between age groups and no significant differences are noted. The highest Pb concentration is in the 30-39 group, and the results are consistent with the previous tissues.

The overall mean for these data is 0.230 in the transformed scale and gives a confidence interval of 0.193 to 0.326 µg/g for the true mean of the population under study.

The sampling and analysis component gives a standard deviation of 0.190 in the transformed scale. Taking the antilog gives 1.209, and implies a 20.9 per cent variability between concentration determinations in fat tissue.

The smoking group had a mean value of 0.270 in the transformed scale based on 61 subjects. The non-smokers mean was 0.223 in the transformed scale from 27 subjects. The resulting t-statistic was 1.08, which is not significant. Thus, no effect of smoking on the observed Pb levels could be detected.

iii. Mercury

The analyses of fat tissue for Hg content are shown in Appendix I. There were 163 cases run for Hg, all in duplicate. The geometric means for the age groups are graphed in Figure 29. The mean concentrations are scattered and no trend is noticeable.

The results of the statistical analyses are shown in Table 33. Percentiles of the distribution are estimated from the 163 cases. The median concentration was 0.0052 µg/g, with a 5 to 95 percentile range of 0.0012 to 0.0124 µg/g. The middle 50 per cent of the distribution ranged from 0.0027 to 0.0074 µg/g.

FIGURE 28.   LEAD CONCENTRATION IN FAT TISSUE vs AGE GROUP

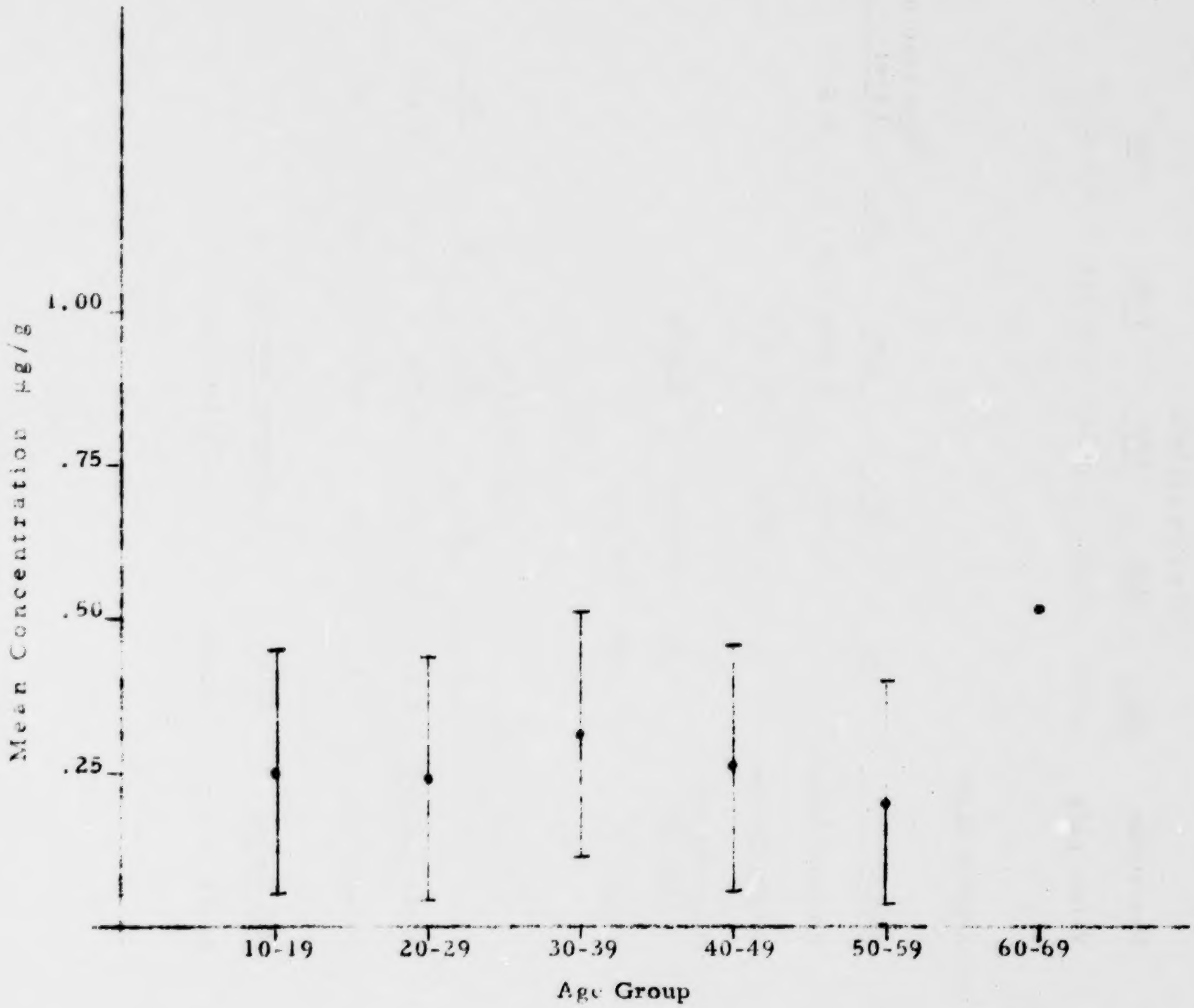

TABLE 32. STATISTICAL SUMMARY FOR LEAD IN FAT TISSUE

Percentile	Percentiles 5th	 25th	 50th	 75th	 95th
Value, μg/g	0.012	0.061	0.141	0.293	0.686

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.2601	0.0520	< 1	N.S.
Within Groups	92	6.5484	0.0712		
Sampling and Analysis	97	3.5160	0.0362		
Total	194	10.3245			

	Age Group 1	 2	 3	 4	 5	 6
Mean $[\ln(1+x)]$	0.222	0.213	0.274	0.235	0.183	0.421
Sample size	17	22	24	16	18	1

Age Group	Mean	Confidence Interval
10-69	0.259	0.1933-0.3262

FIGURE 29. MERCURY CONCENTRATION IN FAT TISSUE vs AGE GROUP

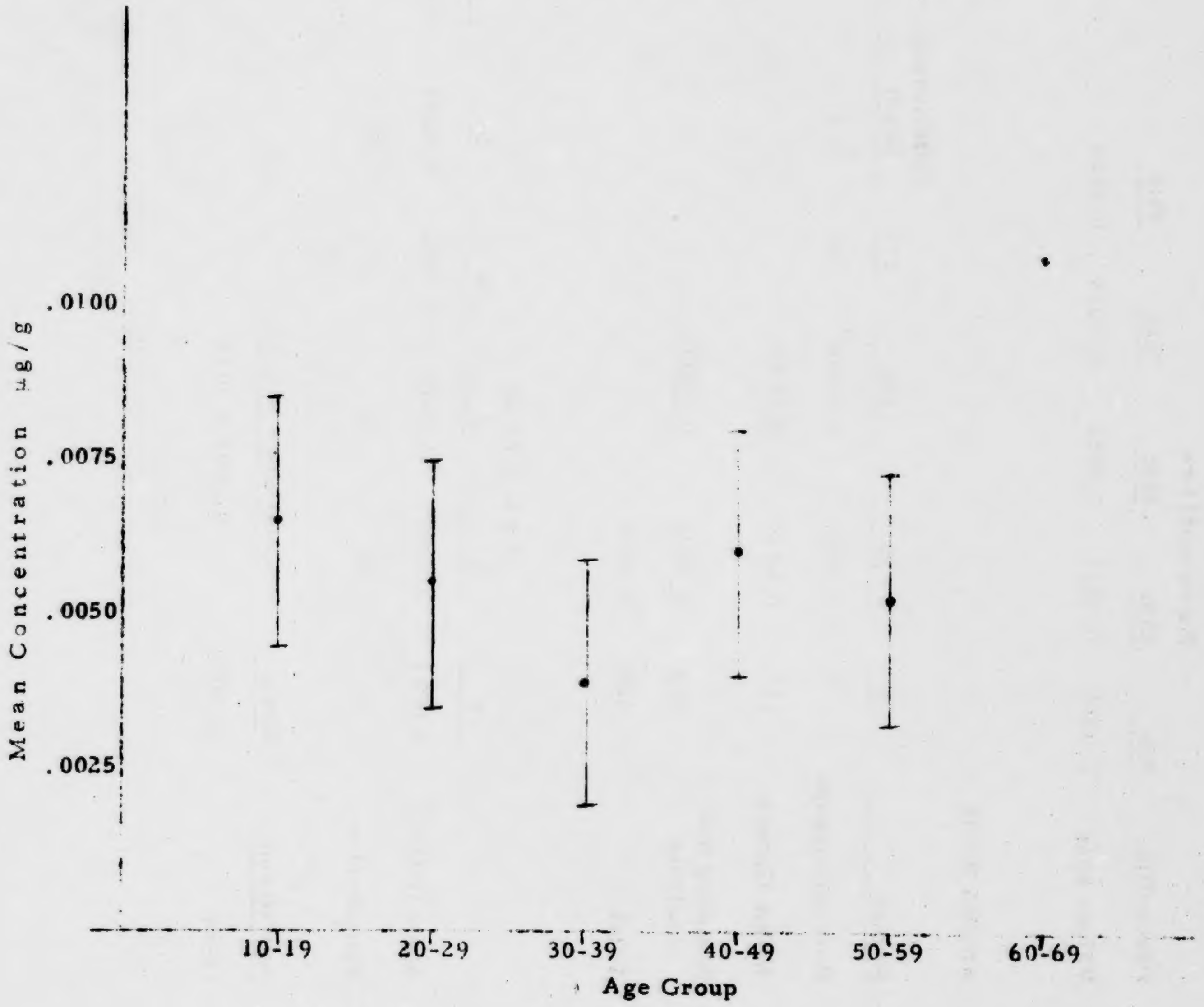

TABLE 33. STATISTICAL SUMMARY FOR MERCURY IN FAT TISSUE

	Percentiles				
Percentile	5th	25th	50th	75th	95th
Value, µg/g	0.0012	0.0027	0.0052	0.0074	0.0124

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.0003	0.00006	2.0	N.S.
Within Groups	157	0.0045	0.00003		
Sampling and Analysis	163	0.0002	0.00000		
Total	325	0.0050			

	Age Group					
	1	2	3	4	5	6
Mean [ln(1+x)]	0.0067	0.0057	0.0040	0.0062	0.0054	0.0108
Sample size	32	38	33	28	31	1

Age Group	Mean	Confidence Interval
10-69	0.0056	0.0097-0.0120

From the F-ratio for between groups, it is determined that no significant differences exist among the mean values. From the means shown in the table, it is apparent that no trend exists, since the values go from higher to lower with no regularity from group to group.

The overall mean of 0.0056 is used to calculate a confidence interval in the transformed scale, using the mean square for within groups. The limits of the 95-per cent confidence interval on the true mean of the population are from 0.0097 to 0.0120 µg/g.

The sampling and analysis component has a negligible sum of squares for mercury, and the variability between duplicate samples is minimal.

The smoking group had a transformed mean of 0.013 as compared to 0.006 for the non-smokers. The t-statistic for these data was 4.28, and is significant beyond the 0.1-per cent level. The conclusion is that higher concentrations of Hg were present in the smokers. The estimated difference is 0.007 µg/g average concentration.

iv. Zinc

The results of the analyses for Zn content of fat tissue are shown in Appendix H. There were 98 subjects analyzed for Zn, all but one in duplicate. The geometric means are plotted in Figure 30 for the age groups.

The summary of the statistical analyses is shown in Table 34. The percentiles of the distribution are estimated from the average for each of the 98 cases. The median was determined to be 2.650 µg/g, with values from 0.400 to 15.150 between the 5th and 95th percentiles. The central 50 per cent of the data ranged from 1.44 to 4.68 µg/g.

The ANOVA table in the summary gives an F-ratio for between groups of 1.02 and is clearly nonsignificant. The conclusion is that age did not affect the observed levels of Zn in fat tissue to any great extent. The transformed means as shown in the table do not indicate any tendency to either increase or decrease with age.

A single confidence interval is calculated for these data using the overall mean of 1.409 for the transformed data. The 95-per cent confidence limits are estimated to be 2.425 to 3.885 µg/g for the true mean concentration.

FIGURE 30. ZINC CONCENTRATION IN FAT TISSUE vs AGE GROUP

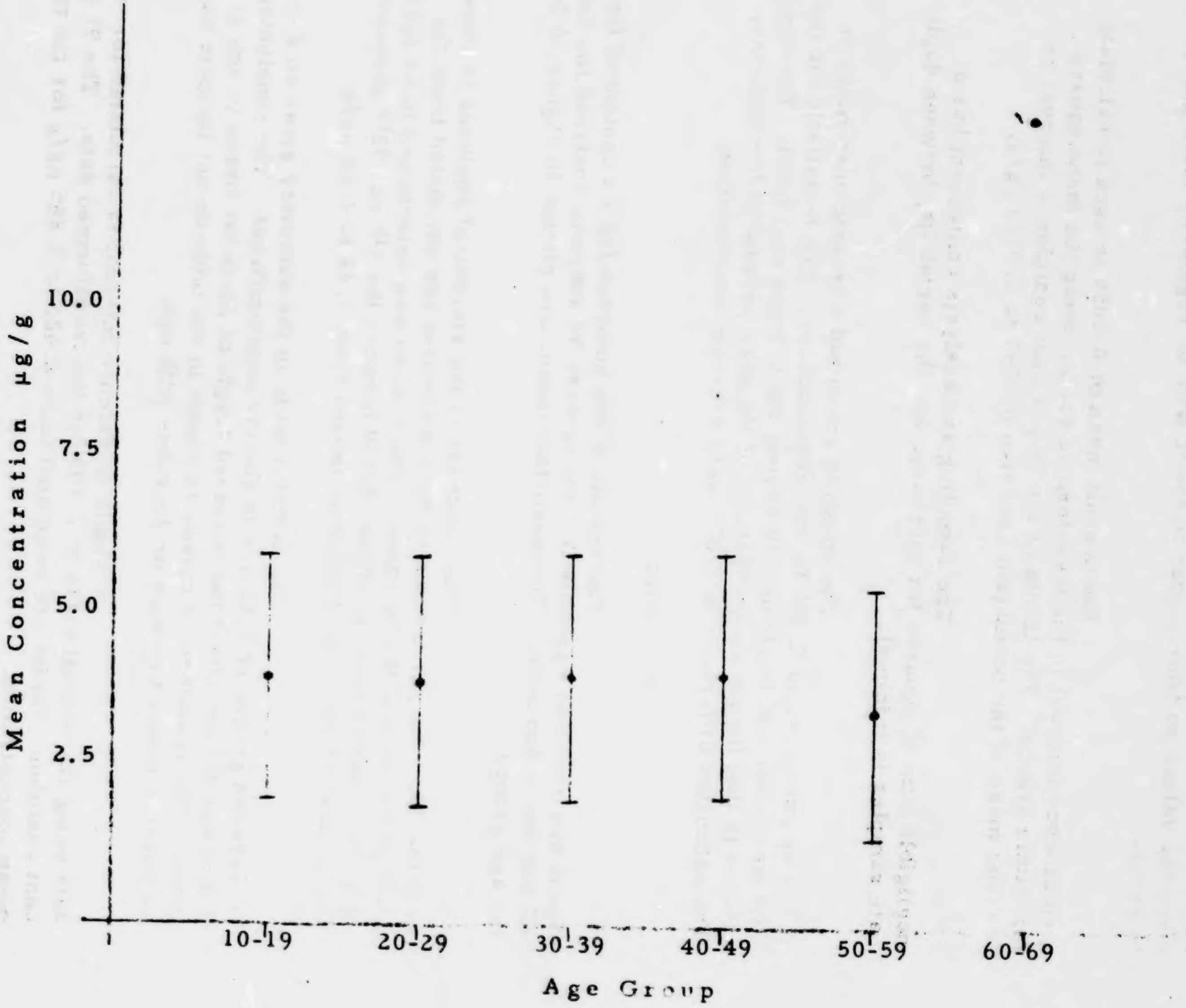

TABLE 34. STATISTICAL SUMMARY FOR ZINC IN FAT TISSUE

Percentiles

Percentile	5th	25th	50th	75th	95th
Value, µg/g	0.400	1.440	2.650	4.680	15.150

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	4.1001	0.8200	1.02	N.S.
Within Groups	92	74.0173	0.8045		
Sampling and Analysis	97	14.7913	0.1525		
Total	194	92.9087			

Age Group

	1	2	3	4	5	6
Mean [ln(1+x)]	1.396	1.377	1.452	1.504	1.251	2.586
Sample size	17	22	24	16	18	1

Age Group	Mean	Confidence Interval
10-69	3.092	2.425-3.885

The sampling and analysis standard deviation for these data is estimated to be 0.391 in the transformed scale, which gives 1.478 when the antilog is taken.

The mean of the smoking group was 1.66 in the transformed scale as compared to 1.35 for the non-smokers. The t-statistic was calculated as 3.46, which exceeds the 0.1-per cent level of the t distribution. The conclusion is that smokers had higher concentrations of Zn, estimated to be 1.40 μg/g on average.

3. Multi-Tissue Results

a. Cadmium

The highest mean concentration of Cd was observed in kidney tissue, followed in order by liver, pancreas, muscle, and fat tissues. For all tissues, age was determined to have a significant effect on the observed levels for Cd, and a linear trend was detected in all cases. The tendency was observed for the concentration to rise up until ages 40-49, then to level off.

In each tissue, the results of the test for the effect of smoking on Cd concentration in the body revealed that the group which regularly smoked cigarettes had significantly higher average concentrations, and that the significance level exceeded the 0.5-per cent value in all cases. Thus, there is strong evidence that cigarette smoking results in higher body burdens of Cd.

b. Lead

The concentration of Pb was highest in the kidney tissue, followed in order by pancreas, liver, fat, and muscle tissues. No significant age effect could be determined, but there was a tendency for the greatest concentration to occur between the ages of 20 and 39.

The results of the investigations on smoking paralleled the results for Cd. Significantly higher values were reported for the concentration of Pb in liver, pancreas, and kidney tissues, anda nearly significant difference was reported for muscle tissue. The difference was insignificant for fat tissue, but a higher mean was observed for the smoking group. There was considerable variability between fat determinations which meant that a greater difference between means was required for significance in fat than in the other tissues. The indication is, then, that cigarette smoking results in higher body burdens of Pb.

c. Mercury

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The highest levels of Hg were observed in the kidney tissue, followed in order by liver, pancreas, fat and muscle tissues. The age group of the individual was not determined to have a significant effect on the observed concentration for any of the tissues studied.

The results of the examinations for a smoking effect were interesting in that no consistent pattern existed. For liver and muscle tissues no difference was detected between the two groups. The pancreas tissue and fat tissue results showed a higher Hg concentration among smokers. The kidney tissue, however, revealed that significantly lower concentrations were observed among the smokers than among the non-smokers.

d. Zinc

The highest concentrations of Zn were observed in muscle tissue, followed by liver, kidney, pancreas, and fat tissues. No age effect was detectable for liver, muscle, or fat concentrations. A linear increase was observed with age in kidney tissue, and a linear decrease with age in pancreas tissue.

The investigation into the effects of cigarette smoking revealed that higher concentrations of Zn could be expected in kidney and fat tissues, but that no effect was discernable in liver, muscle, or pancreas. Thus, cigarette smoking is indicated to affect the body burden of Zn in those two tissues.

B. Live Volunteer Study

1. Recruitment Activities

Using the methods described, questionnaire forms were obtained for sufficient volunteers, and the following numbers of qualified participants were selected for use in the study:

Age (years)	No. of Participants
1-10	15
10-19	8
20-29	16
30-39	7
40-49	16
50+	24

Examination of the possible reasons to explain the difficulties encountered in recruitment leads to the following observations. The requirement for 24-hour samples is the most frequently criticized characteristic by potential volunteers. They complain of the necessity of carrying sample containers away from home, or being constrained to stay at home for a specific 24-hour period. Overnight samples offer many times less resistance from potential volunteers than do 24-hour samples. A second observation adds to the result of that stated first. This is the necessity of recruiting males rather than females, or a mixture of these sexes. It is the observation of the study team that males do not relate to or respond to the giving of urine or feces samples for study purposes nearly as easily as females. This observation possibly relates to such things as diapers, bathroom cleaning, etc., being considered "woman's work" in the minds of some. In any case the double requirement of all male participation and 24-hour excretia samples resulted in a very difficult recruitment effort.

2. Questionnaire Data

The questionnaire data was used to describe the individuals who participated in the survey and to verify that the subjects could be considered non-exposed. The results obtained which are pertinent to this study are summarized below.

The length of residency in the city or town was used to verify that the individuals could be considered to be living in a non-exposed environment. Of the 72 individuals over the age of 10, 38 had resided in the same city or town for nine years or more and only 10 had been residents for one year or less. The environmental non-exposure criterion thus appears satisfied for these subjects.

The occupation of the individual was screened to ensure that occupational exposure was not indicated. The length of time the subject had worked for the same employer was used to reaffirm the non-exposure status. The individuals over 19 were used since they constitute the working sector of the sample under study. Twenty-six of these individuals had been with the same employer for at least nine years, and 14 of them for one year or less. The majority of the individuals had been with the same employer for at least four years, and the criterion of non-occupationally exposed can be stated to be satisfied.

As mentioned above, the autopsy cases were selected to be not excessive users of medication in order not to bias the results. The living subjects were questioned concerning certain chronic illnesses and the summary of these results is presented in Table 35.

TABLE 35. SUMMARY OF CHRONIC ILLNESSES REPORTED FOR LIVING SUBJECTS

Illness	Frequency	Percentage
Malignancies	1	1,2
Diabetes	2	2.3
Heart Conditions	6	7.0
Hypertension	6	7.0
Arthritis and Rheumatism	5	5.8
Rheumatic Heart Disease	1	1.2
Thyroid Disease	1	1.2
Liver Disease	4	4.7
Kidney Disease	1	1.2

The highest frequency was reported for heart conditions and hypertension, but only amounted to seven per cent of the sample. For the thyroid, liver, and kidney diseases, the subject was requested to specify the type of disease if he gave a positive response. The thyroid disease was reported to be low thyroid. There were four cases of liver disease, two of acute infectious hepatitis and two of jaundice. The reported kidney disease was not specified.

The 63 subjects over 19 were divided into three groups based on their smoking habits. The current smokers comprised 14 subjects, while people who had smoked but did not at the time of the study, referred to as current non-smokers, numbered 21 and the remaining 28 had not smoked as many as 100 cigarettes in their lifetime.

3. Living Subjects

The feces and urine samples from the volunteer participants were analyzed for their Cd concentration and the results are included in Appendix J to this report. These data were used in the statistical analysis referred to Section II. F. 6 above and the results are shown below for each medium separately.

a. Feces

The geometric means for each age group are graphed and presented as Figure 31. As can be seen, the highest concentrations are observed in the two lowest age groups, after which an almost constant average is observed.

The summary of the statistical analyses is shown in Table 36. The percentiles of the distribution are calculated using the average values for all 86 subjects. The median is estimated to be 0.097 μg/g, with a normal range, excluding high values, of 0.052 to 0.205 μg/g. The interquartile range for these data was from 0.083 to 0.132.

The ANOVA is used to test for the presence of an age factor. The F-ratio for significance of the between group term is 1.20 which does not exceed a tabled value. As can be seen from the means of the transformed data, there is a slight drop in average concentration after group 2, and then the means remain fairly constant over the remaining groups.

FIGURE 31. CADMIUM CONCENTRATION IN FECES vs AGE GROUP

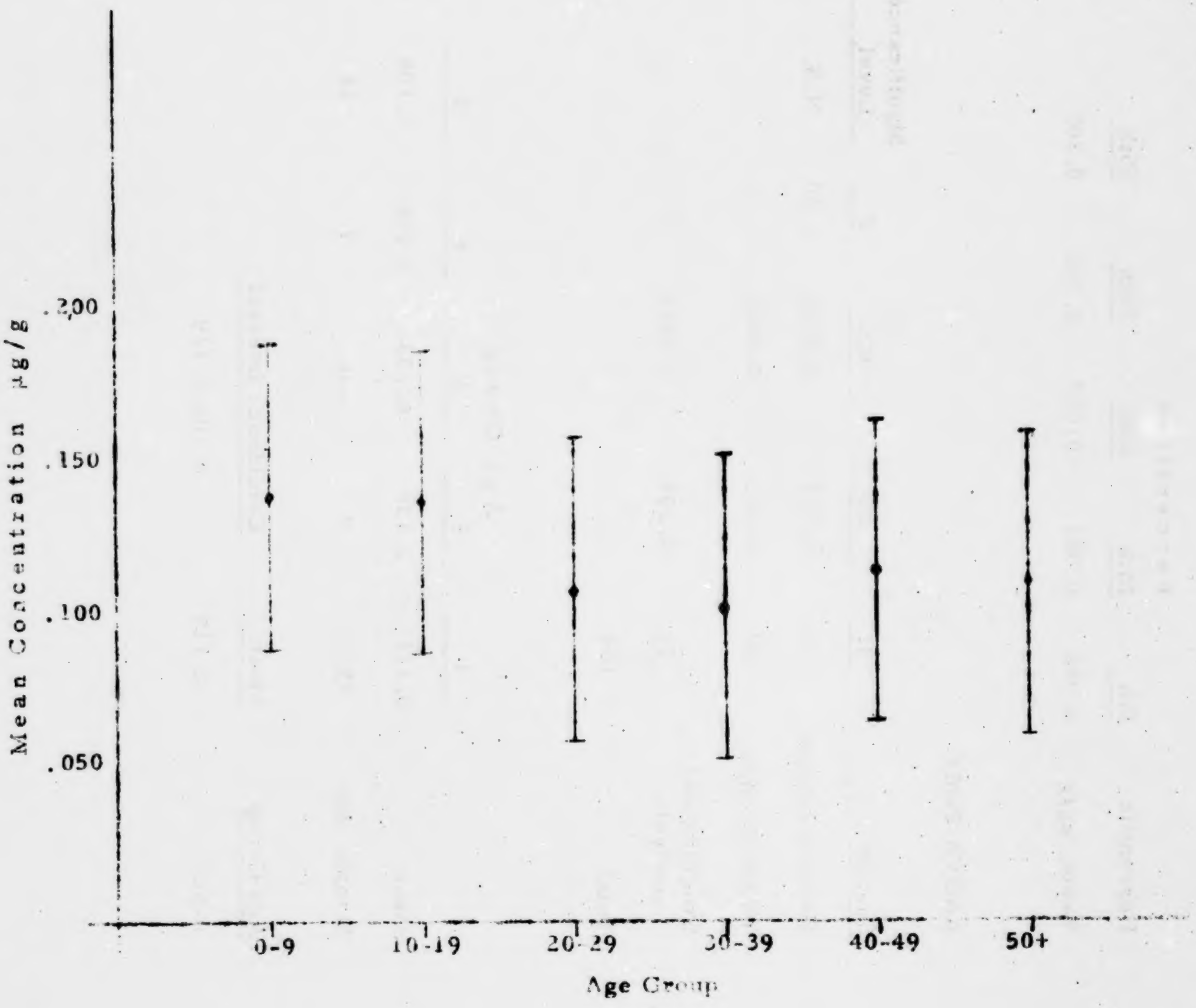

TABLE 36. STATISTICAL SUMMARY FOR CADMIUM IN FECES

	Percentiles				
Percentile	5th	25th	50th	75th	95th
Value, μg/g	0.052	0.083	0.097	0.132	0.205

ANOVA Table

Source	df	SS	MS	F	Significance Level
Between Groups	5	0.012	0.0024	1.20	N.S.
Within Groups	80	0.163	0.0020		
Sampling and Analysis	79	0.199	0.0025		
Total	164				

	Age Group					
	1	2	3	4	5	6
Mean	0.131	0.130	0.103	0.098	0.109	0.106
Sample size	15	8	16	7	16	24

Age Group	Mean	Confidence Interval
0-50+	0.119	0.108-0.129

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The overall mean of 0.112 in the transformed scale is used to construct a 95-per cent confidence interval on the true mean of 0.108 to 0.129 μg/g. The 86 mean values for individuals are used to construct a frequency distribution for Cd concentration.

The sampling and analysis variation is estimated from the ANOVA. There are less than the nominal 86 degrees of freedome due to several samples which were insufficient to run duplicate analyses. The mean square for those with duplicate samples gives a standard deviation of 0.050, which translates into a value of 1.051 in the original scale.

The effect of smoking on observed Cd levels is tested by comparing the smokers within the sample against first the non-smokers, then the current non-smokers. The calculated means are 0.109, 0.099, and 0.106 for non-smokers, current non-smokers, and smokers, respectively, in the transformed scale. Using a t-test as before, no difference can be detected for the smoking group against either non-smokers or current non-smokers. The calculated t's are -0.18 and 0.41, respectively. It is concluded, then, that no difference in the concentration of Cd in feces occurred as a result of smoking cigarettes.

b. Urine

The geometric means for the six age groups are plotted and presented in Figure 32. There is a tendency for these values to rise with age and to reach a maximum in the 40-49 group. This is consistent with the results for the tissues discussed above.

The summary of the statistical analyses is shown in Table 37. The percentiles are calculated for the distribution as a whole. The median concentration is estimated to be 0.533 μg/l. with a 5th to 95th percentile range of 0.148 to 1.293 μg/l. The interquartile range is from 0.329 to 0.696 μg/l.

The ANOVA is also summarized in the table. For these data, the between age group factor has an F-ratio which is significant beyond the one-per cent level. A t-statistic is used to test the hypothesis of a linear trend, and the calculated value of 5.30 is significant at the 0.1-per cent level. Thus, we can say that a strong tendency does exist for the concentration to increase with age.

Since the age factor was significant, a separate confidence interval is calculated for each mean value.

TABLE 32. CADMIUM CONCENTRATION IN URINE vs AGE GROUP

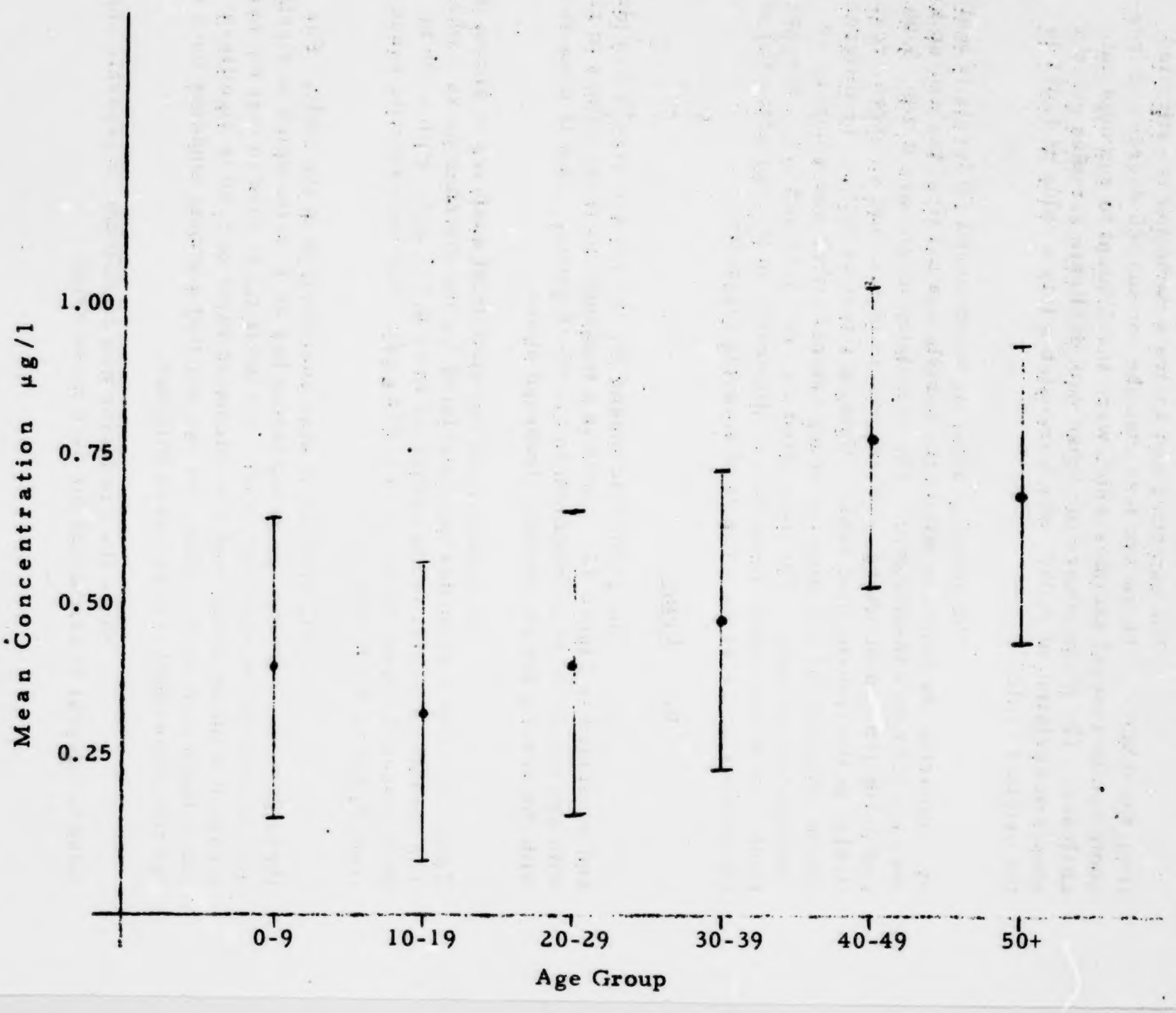

TABLE 37. STATISTICAL SUMMARY FOR CADMIUM IN URINE

	Percentiles				
Percentile	**5th**	**25th**	**50th**	**75th**	**95th**
Value, µg/l	0.148	0.329	0.533	0.696	1.293

ANOVA Table

Source	**df**	**SS**	**MS**	**F**	**Significance Level**
Between Groups	5	0.994	0.199	5.85	< 0.01
Within Groups	80	2.757	0.034		
Sampling and Analysis	84	1.855	0.022		
Total	169				

	Age Group					
	1	**2**	**3**	**4**	**5**	**6**
Mean [ln(1+x)]	0.347	0.288	0.352	0.403	0.586	0.533
Sample size	15	8	16	7	16	24

Age Group	**Mean**	**Confidence Interval**
0- 9	0.415	0.289-0.553
10-19	0.334	0.174-0.516
20-29	0.422	0.300-0.556
30-39	0.496	0.305-0.716
40-49	0.797	0.642-0.966
50+	0.704	0.582-0.835

The sampling and analytical variation has 84 degrees of freedom with two of the individuals not having duplicate samples analyzed. The mean square for sampling and analysis from the ANOVA gives an estimated standard deviation of 0.148 in the transformed scale, which represents reasonably wide variation between duplicates.

The effects of smoking are evaluated using the same approach as for the feces. The urine data provided a quite different result, however. The significance level of the test for differences in non-smokers and smokers was less than one per cent, and the smokers showed significantly higher levels of Cd in their urine. The means for smokers, current non-smokers and non-smokers were 0.564, 0.544, and 0.404, respectively. The t-statistics for the two comparisons were 3.30 for smokers vs non-smokers, and 0.39 for smokers vs current non-smokers.

Of some curiosity is the fact that the smokers were not significantly different from the current non-smokers. Of the 21 individuals falling into this group, only five had quite smoking within the previous five years, and the longest time was reported to be 32 years. A possible explanation for this comes from the average age of the subjects. The current non-smokers had an average age of 48 compared to 40 for the smokers. Since the age factor was determined to be significant and this represents nearly one age bracket's difference, this could explain this result.

4. Interrelationship Between Feces and Urine for Cadmium Content

The analytical results for Cd in feces show the highest concentrations in the two lowest age groups. After ages 10-19, there is a drop-off and the concentration is essentially constant for the remaining age groups. There were no observable differences between the smoking group and either former smokers or non-smokers. As such, the concentration of Cd in feces may be taken to be an indicator of the amount of Cd ingested, and not related to body burden of the metal.

Urine, on the other hand, provided the same type of information as was available from the autopsy tissues. The concentration tended to increase in a linear fashion with age up to ages 40-49, then decrease slightly. Among cigarette smokers, higher concentrations were observed than in non-smokers but equivalent concentrations to former smokers. These results indicate that Cd in urine may be indicative of total body burden of the metal as opposed to daily intake.

IV. DISCUSSION

A. Comparison of this Study to Other U.S. Studies

As mentioned in the Introduction, the estimates of daily dietary intake of cadmium in the United States have been reported to range between 20 and 130 μg(10)(11). The earlier data of Schroeder, et al.(20) and Tipton and Stewart had much higher values than this in that they estimated the daily intake of cadmium to be between 200 and 500 μg. Also, Murthy, Rhea, and Peeler(10) have reported relatively high values with a mean of about 90 μg per day. Speculation is that sodium chloride interfered with the cadmium determinations in the above-mentioned investigations such that much higher values were obtained. Schroeder and Balassa(11) analyzed cadmium using the dithiozone method and estimated that the daily intake of cadmium could vary between 40 and 60 μg depending on foods chosen. Bostrom and Wester (26) reported that the probable daily intake of cadmium was around 12 μg per day. The results from our study indicate that the average daily intake of cadmium as estimated from fecal excretion range somewhere between 15 and 20 μg per day. These values are consistent with the data obtained in recent years utilizing atomic absorption procedures.

A number of investigators have reported that cadmium tends to increase in tissues with age. This study tended to confirm this result in that cadmium in five tissues (kidney cortex, liver, pancreas, fat, and muscle) tended to increase with age, with the most pronounced increase kidney cortex. The recent study by Gross, et al.(21), is one of the most comparable to the program to this study. Gross utilized autopsy samples from accidental death and from natural death but he emphasized the normal deaths from those who died suddenly so that the total comparison should be valid. Gross' data on kidney cortex cadmium levels showed median concentrations from a low of 7.5 in young age groups to a high of 30 μg/g wet weight in older groups, while in the study reported here, the medians ranged from 7.4 to a high of 23.6 μg/g wet weight. Thus the values for kidney cortex in our study were very similar for the lower age groups, but tended to be lower in our studies than in Gross' study for the age groups 30 and above. A similar pattern is seen in liver tissue in which there was very good agreement in the younger age groups and slightly lower amounts in our study in older age groups. For example in the 40 to 50 age group, their values were approximately 1.7 μg/g wet weight while in our study it was 1.3 μg/g wet weight.

As mentioned in the Introduction, it was reported in the literature that body burden of cadmium increases with age from virtually none at birth to about 30 mg in the fifth decade of life(12). Our calculation of total body burden for a man age 50 is 15 mg, which is one-half that used in the previous estimate. Thus, the total body burdens from age 10 to 19 are 5.83, 9.04 in age 20-29, age 30-39 it was 12.22, age 40-49 it was 15.04, and age 50-59 it was 14.77 mg. There is little information in the literature for comparison with tissue levels of lead, mercury, and zinc comparable to this investigation.

Previous estimates of the contribution of cadmium from cigarette smoking ranged from 2 to 10 μg per day. Since cigarette smoking results in respiratory exposure to Cd, it is likely that some 50 per cent of this cadmium would be absorbed. Our study found consistently higher levels of cadmium in cigarette smokers than in non-smokers. Calculation of body burden of 30-49 year old male smokers vs. a non-smoker provides the following numbers: 14.9 mg smoker vs. 10.3 mg non-smoker. These calculations imply that cigarette smoking is a major contributor to cadmium intake.

B. Comparison with Foreign Studies

Elinder, et al.(16) helped perform a large scale study of the cadmium burden in a Swedish autopsy population. They reported on 290 subjects autopsied for presence of cadmium and zinc in kidney cortex, liver, and pancreas. The levels of cadmium in the three tissues (liver, kidney and pancreas) are slightly lower than similar values obtained in this autopsy study performed in the United States. Similarly, levels of cadmium in urine and feces appear to be slightly lower in the Swedish study than in this study. Much higher values of cadmium had been reported from Japan, Tsuchiya, et al.(22). For example, in kidney cortex the levels in the United States ranged from means of 7.3 to a high of 26.3 μg/g wet weight. The range in Japan was 21 to 70 μg/g wet weight. Higher values are also seen in liver and pancreas. Feces levels in Japan appear to be more than twice those seen in populations in the United States. Urinary values for cadmium are also more than twice the values seen in the U.S. studies. Overall, the data from this investigation performed in the United States are very close to the values reported in Sweden with slightly higher tissue values in most instances. Fecal levels are also slightly higher which indicates that intake is higher. Japanese levels appear to be substantially higher than both Swedish and U.S. populations in tissues and in intake as measured by cadmium in feces.

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The results in this study for zinc are similar to that reported by Elinder et al.(17) for 292 subjects autopsied in Sweden. They reported that zinc accumulated in kidney cortex with age but not in liver or pancreas. We found the same relationship. The means for zinc in kidney cortex in our study ranged from 38.05 to 50.50 while for the Swedish study they were 28 to 38. For liver, their mean for all ages was about 45 while our samples yielded a mean of approximately 55. In pancreas samples, the mean levels tended to decrease with age in both studies although not significantly. The mean for zinc in the Swedish study was 32 while in ours it was approximately 25. Thus, zinc levels in the United States autopsies were lower than those from Sweden with the exception of pancreas where the reverse was found.

The results of these two studies for zinc are in agreement with Tipton (1960), Schroeder, et al.(20), Anke and Schneider(24), Piscator and Lind(23), and Hammer, et al.(25). Increasing levels of zinc and cadmium in kidney cortex were also seen in these studies.

C. Body Burden of Cadmium

The total body burden of Cd is estimated for a "standard man." The definition of a standard man was developed for this study from the existing literature(11, 19, 20) and is defined as a man of total weight equal to 70 kg, apportioned according to the following scheme:

Tissue	Weight, kg
Muscle	30
Liver	1.7
Kidney	0.3
Pancreas	0.07
Fat	10
Remaining tissues	27.93
Total	70.00

To estimate the body burden, the mean concentration of Cd in each type of tissue is multiplied by the estimated weight of that tissue to determine total µg of Cd expected. The average of the muscle and fat means is used as the average concentration of the remaining tissues.

Since age differences were noted for all tissues for Cd content, separate body burdens are calculated for each age group except 60-69.

These are presented in Tables 38 through 42. The totals for each group can be compared to existing literature(6) to indicate the relative magnitude of the body burdens calculated for these individuals. For all age groups, the calculated total mg for Cd is consistent with the expected ranges for countries with known low exposure to Cd. The first three groups are comparable to data from W. Germany, which has an expected range of 5.1 to 12.9 mg for males from 19-62. The two older groups correspond to United Kingdom data for males from 49-56, where the range was from 13.5 to 16.6 mg.

To investigate the effects of cigarette smoking on body burden, the individuals in the 30-39 and 40-49 groups were pooled for comparison of smokers and non-smokers. These age groups were selected since they represent the highest probable body burdens based upon the tissue results above. There were 48 smokers and 13 non-smokers in the combined results and these were used to obtain separate mean concentrations for each group in each tissue except fat. The reduced data set for fat gave 29 smokers and 11 non-smokers. Separate body burdens were calculated for each group and the results presented in Table 43.

As can be seen, the estimated total Cd for smokers was 14.90 mg as opposed to 10.31 mg for non-smokers. This represents an increase of 45 per cent over the non-smoking group. The implication is, then, that there is a marked effect of cigarette smoking on the expected body burden of Cd.

TABLE 38. BODY BURDEN OF CADMIUM FOR STANDARD MAN AGES 10-19

Tissue Type	Tissue Weight, kg	Mean Concentration		Total	Total
		µg/g	µg/kg	µg	mg
Muscle	30	0.032	32	960	0.96
Liver	1.7	0.819	819	1392	1.39
Kidney	0.3	7.671	7671	2301	2.30
Pancreas	0.07	0.326	326	22.82	0.02
Fat	10	0.029	29	290	0.29
Remaining	27.93	(0.031)*	31	865.8	0.87
Total	70.00				5.83

* Average of Muscle and Fat

TABLE 39. BODY BURDEN OF CADMIUM FOR STANDARD MAN
AGES 20-29

Tissue Type	Tissue Weight, kg	Mean Concentration µg/g	Mean Concentration µg/kg	Total µg	Total mg
Muscle	30	0.054	54	1620	1.62
Liver	1.7	1.028	1028	1747.6	1.75
Kidney	0.3	12.985	12985	3895.5	3.90
Pancreas	0.07	0.419	419	29.33	0.03
Fat	10	0.0411	41.1	411	0.4
Remaining	27.93	(0.048)*	48	1341	1.34
Total	70.00				9.04

* Average of Muscle and Fat

TABLE 40. BODY BURDEN OF CADMIUM FOR STANDARD MAN AGES 30-39

Tissue Type	Tissue Weight, kg	Mean Concentration µg/g	Mean Concentration µg/kg	Total µg	Total mg
Muscle	30	0.054	54	1620	1.62
Liver	1.7	1.300	1300	2210	2.21
Kidney	0.3	22.012	22012	6603.6	6.60
Pancreas	0.07	0.553	553	38.71	0.04
Fat	10	0.041	41	410	0.41
Remaining	27.93	(0.048)*	48	1340.6	1.34
Total	70.00				12.22

* Average of Muscle and Fat

TABLE 41. BODY BURDEN OF CADMIUM FOR STANDARD MAN AGES 40-49

Tissue Type	Tissue Weight, kg	Mean Concentration		Total	Total
		µg/g	µg/kg	µg	mg
Muscle	30	0.086	86	2580	2.58
Liver	1.7	1.286	1286	2186	2.19
Kidney	0.3	25.900	25900	7770	7.77
Pancreas	0.07	0.781	781	54.67	0.05
Fat	10	0.052	52	520	0.52
Remaining	27.93	(0.069)*	69	1927.2	1.93
Total	70.00				15.04

* Average of Muscle and Fat

TABLE 42. BODY BURDEN OF CADMIUM FOR STANDARD MAN AGES 50-59

Tissue Type	Tissue Weight, kg	Mean Concentration µg/g	Mean Concentration µg/kg	Total µg	Total mg
Muscle	30	0.107	107	3210	3.21
Liver	1.7	0.790	790	1343	1.34
Kidney	0.3	25.338	25338	7601.4	7.60
Pancreas	0.07	0.767	767	53.69	0.05
Fat	10	0.044	44	440	0.44
Remaining	27.93	(0.076)*	76	2122.7	2.12
Total	70.00				14.77

* Average of Muscle and Fat

TABLE 43. COMPARATIVE BODY BURDENS OF CADMIUM FOR SMOKERS AND NON-SMOKERS, STANDARD MAN BETWEEN 30 AND 49 YEARS OF AGE

Tissue Type	Tissue Weight, kg	Mean Concentration, μg/g		Total mg	
		Non-smokers	Smokers	Non-smokers	Smokers
Muscle	30	0.057	0.072	1.71	2.16
Liver	1.7	1.076	1.342	1.83	2.28
Kidney	0.3	16.69	27.50	5.01	8.25
Pancreas	0.07	0.539	0.686	0.04	0.05
Fat	10	0.038	0.048	0.38	0.48
Remaining	27.93	(0.048)*	(0.060)*	1.34	1.68
Total	70.00			10.31	14.90

* Average of muscle and fat.

V. CONCLUSIONS

1. Cadmium concentrations of white male autopsy samples are highest in kidney cortex followed by liver and pancreas. The levels are much lower in muscle and fat tissue. These results are similar to data reported in the literature. The distribution of cadmium within tissues was consistent in the five age groups examined (10-19, 20-29, 30-39, 40-49, and 50-59).

2. Cadmium levels in the five tissues examined tended to increase with age. The most pronounced increase was seen with kidney in which the age group 10-19 had a mean of 7.67 μg/g of cadmium while the 50-59 age group had 25.34 μg/g.

3. Urinary excretion of cadmium increased slightly with age while levels present in feces were similar in all age groups with slightly lower levels present in older males. It would, therefore, appear that the increased levels of cadmium seen in the tissues with age is not due to an increased consumption of cadmium with age. Fecal cadmium measurements provide a useful assessment of the dietary consumption of cadmium.

4. A preliminary comparison of cadmium levels found in this study with data from Sweden and Japan indicates that the Japanese tissue, urine, and feces levels are substantially higher, while the Swedish levels are slightly lower.

5. Concentrations of lead were highest in liver followed by kidney, pancreas, fat, and muscle. This distribution was similar for all age groups. No age related trend was observed for any of the tissues tested.

6. The highest concentrations of zinc were found in muscle followed by liver, kidney, pancreas, and fat. Only kidney cortex showed an increase in concentration of zinc with age.

7. Concentrations of mercury in all tissues were low with kidney being highest, followed by liver, pancreas, fat, and muscle. The distribution within tissues was consistent for all age groups tested and no age related trends in mercury concentrations were found.

8. Current cigarette smokers had higher levels of cadmium in all the tissues tested. The lead concentration was significantly higher in liver, pancreas, and kidney tissues, and slightly higher for muscle and fat tissues than the non-smokers. Zinc and mercury concentrations were significantly higher in pancreas and fat tissues for the smokers, but lower in kidney tissue than the non-smoker.

9. Non-smokers had lower levels of cadmium in their urine than both current and past cigarette smokers. The cadmium levels in feces, however, were unrelated to smoking habits.

10. Low temperature ashing of autopsy tissue samples followed by direct analysis of the dissolved ash with flame or flameless atomic absorption spectrophotometry (AAS) provides an accurate and reliable means to determine Cd, Pb, and Zn concentrations in human tissues.

11. Extraction of Cd as the iodocadmate complex from digested feces (H_2SO_4 - H_2O_2) using LA-2 in decane and flame AAS provides a rapid and quantitative method to measure Cd-feces levels.

12. Mercury determinations in digested tissues (HNO_3 - $HClO_4$) by the cold-vapor AAS technique is quantitative.

13. Estimates of total body burdens of cadmium are lower than for other studies in the United States. Body burden estimates ranged from means of 5.83 to 15.04 mg of cadmium.

14. The contribution of cigarette smoking to total body burdens of cadmium appears to be quite significant. Non-smokers' body burden was calculated to be 10.3 mg while smokers had 14.9 mg of cadmium.

15. Results of this study for zinc are in agreement with findings of other investigators in that zinc levels in kidney cortex increase with age while other tissue levels remain fairly constant with age.

VI. RECOMMENDATIONS

1. The Environmental Protection Agency should conduct more programs aimed at examining tissue levels of environmental pollutants collected from participating medical examiners in metropolitan areas of the United States. The approach used in this study of examining several tissues from a range of age groups of accidental death autopsies could be used for other pollutants, both sexes, other ethnic groups, and other metropolitan areas. These types of programs would provide the Environmental Protection Agency with an accurate assessment of current body burdens of environmental pollutants in a cross-section of the general population.

   It is recognized that the availability of autopsy material and supportive personal data on the deceased is difficult to obtain in many cities. Every effort should be made by the EPA and other organizations to make the maximum usage of these samples.

2. Cooperative efforts between the United States and other countries should be encouraged, especially the type performed under this contract. Standardized sampling and analysis protocols were established prior to the collection of the data, thus the comparability of data between laboratories and countries is feasible. Valuable insight into the assessment of possible health effects of environmental pollutants can be obtained in this manner.

3. Increased efforts should be made within this country and other countries to standardize the analytical methodologies used to generate trace metal data. This would allow direct comparison of environmental data produced world-wide.

4. Additional efforts should be undertaken to assess the contribution of cigarette smoking to the accumulation of toxic metals such as cadmium.

APPENDIX A

EPA Cadmium Study
Protocol for Collection of Urine and Feces Samples

EPA CADMIUM STUDY
PROTOCOL FOR COLLECTION OF URINE AND FECES SAMPLES

Urine and fecal samples will be collected from 80 white males, without occupational exposure to cadmium, living in the same metropolitan area from which the autopsy samples are being collected. The 80 subjects shall consist of 20 subjects from each of four age groups; 10 years or less, 20-30 years, 40-50 years and greater than 50 years. Each individual will be sampled twice for 24-hour samples of urine and feces. The following information will be recorded on each of these individuals: age, sex, occupation, chronic diseases, length of residency in study area, smoking history and dietary history.

Contacts with Volunteers

It is suggested that one or more hospitals or medical schools be contacted as a potential source of volunteers. Employees of these institutions would have some knowledge of medical procedures; thus, they should be able to collect authentic 24-hour specimens. The head of the hospital or medical school should be contacted to obtain permission to solicit employees and their families for the study. Arrangements should be made to advertise the study by announcements at staff meetings, etc. and by posting information on bulletin boards. This information should include a brief description of the objectives of the study, the types and numbers of volunteers needed and the time and location of an indoctrination meeting. The meeting should be held at a time and place convenient to the volunteers, perhaps during lunch or after work.

A member of the project team familiar with all aspects of the project should be present to answer questions. Individuals wishing to volunteer (also members of their family) will fill out an information sheet such as that shown in Figure 1. It is suggested that $20 be paid to each volunteer for the completion of the study. After the specific study group is selected (80 white males, 20 in each of the four age groups), each should be notified of his selection and provided with a time schedule for collection of samples. Approximately two weeks should be provided between the first meeting and the collection of samples. Those individuals who completed the information sheet and were not selected for the study should be notified of their non-selection.

Collection of Samples

The initial meeting with the selected volunteers should include the following:

1) Completion of an informed consent form on each volunteer,
2) Instruction of each volunteer on the sampling requirements,
3) Handing out of sample containers for collection of urine and feces.

The informed consent is a requirement of the U.S. Government for studies involving human volunteers. A suggested form is shown in Figure 2. The purpose of this form is to provide a record that the Project Team was present on the day specified to answer all questions about the study for each volunteer and that the volunteer understood the objectives of the study and his part in the study and that he agreed to participate. This form must

OMB#158-S75007

STAFF USE ONLY
Cols. 1-4
ID# ☐☐☐☐

FIGURE 1
CADMIUM QUESTIONNAIRE

1. Name: ______________________________ (Last Name) (Initials)		5-30
2. Address: Street ______________________		31-50
City ____________ State ____________		51-65
Zip Code ______________________		66-70
Telephone, Residence ______________________		71-77
Telephone, Work ____________ Ext. ________	**P 1**	79-80 5-15
3. How old were you on your last birthday? ______ years	☐☐	16-17
4. What is your present occupation? ____	☐☐	18-19
5. How many times have you changed occupations during the past five years? _____ times	☐	20
6. Your present employer is: ____	☐☐☐	21-23
7. How long have you been employed by your present employer? ________ years	☐	24
8. How many years have you lived in your present city or town? _________ years	☐	25
9. Have you ever smoked as many as five packs of cigarettes, that is as many as 100 cigarettes during your entire life? (1) Yes (2) No	☐	26
10. Do you now smoke cigarettes? (1) Yes (2) No	☐	27
11. If you are a current or ex-cigarette smoker, how many cigarettes do (did) you smoke per day? (1) 1-5 cigarettes per day (2) 6-14 cigarettes per day (3) 15-25 cigarettes per day (4) 26-34 cigarettes per day (5) 35 or more cigarettes per day	☐	28
12. If you are a current or an ex-cigarette smoker, how old were you when you first started smoking? __________ years	☐☐	29-30
13. If you are an ex-cigarette smoker, how old were you when you last gave up smoking? ________ years	☐☐	31-32

14. Have you ever been diagnosed as having any one of the following chronic illnesses:

	(1) No	(2) Yes	Type		
Malignancies	____	____		☐	33
Diabetes	____	____		☐	34
Heart conditions	____	____		☐	35
Hypertension	____	____		☐	36
Arthritis and rheumatism	____	____		☐	37
Rheumatic heart disease	____	____		☐	38
Thyroid disease (specify type)	____	____	______________________	☐☐☐	39-41
Liver disease (specify type)	____	____	______________________	☐☐☐	42-44
Kidney disease (specify type)	____	____	______________________	☐☐☐	45-47

15. Are you presently following any of the dietary regimens listed below:
(Check all that apply.)

(1) Bland food ulcer diet
(2) Diabetes
(3) Weight-watchers/reducing
(4) Organic food diet
(5) Vegetarian
(6) None of these

☐ 48

16. How often do you eat shellfish such as shrimp, oysters, crabs, lobster or clams?

(1) More than once a week
(2) About once a week
(3) About once every two weeks
(4) About once a month
(5) Less than once a month
(6) Never

☐ 49

17. How often do you eat liver or kidney?

(1) More than once a week
(2) About once a week
(3) About once every two weeks
(4) About once a month
(5) Less than once a month
(6) Never

☐ 50

YOU HAVE COMPLETED THE QUESTIONNAIRE.
THANK YOU FOR YOUR COOPERATION.

IMNOWO 123456

☐ 51

Revised 7 August 1975

P 2 79-80

Figure 2.
VOLUNTEER'S INFORMED CONSENT

I, ____

residing at ______________________________________

____

hereby acknowledge and certify to the following:

1. That I hereby volunteer and consent to participate as a human test subject in an experiment designed to determine exposure to environmental pollutants.

2. That I have been given, in my opinion, an adequate explanation of the nature, duration and purpose of the experiment, the means by which the experiment will be conducted and any possible inconveniences, hazards, discomforts, risks, and adverse effects on my health which could result from my participation therein;

3. That I have been informed of all appropriate alternative procedures, if any exist, that might be advantageous to me;

4. That I understand my questions concerning procedures which affect me will be answered fully and promptly;

5. That I understand that I have the right to withdraw my consent and to discontinue participation in this experiment at any time without prejudice regardless of the status of the experiment and regardless of the effect of such withdrawal on the objectives and results which the experiment is designed to achieve; and I also understand that my participation in the experiment may be terminated at any time by the investigator in charge of the project or the physician supervising the project regardless of my wishes in the matter;

6. That I hereby understand and agree that the samples collected from me will be analyzed for their content of cadmium, and that these are the only tests that will be made on these samples and that no medicinal compounds will be analyzed.

7. That I attained the age of ______ years on my last birthday which was ________________________________, and that I am executing this Volunteer's Informed Consent as my free act and deed.

Executed this ______th day of ____________________________, 19_____.

over

Volunteer's Informed Consent

Executed in my presence and in
the presence of each other.

Witness	Volunteer
	Person informing volunteer and obtaining volunteer's consent

If subject is a minor, complete the following:
Subject is a minor - age ___________.

Father	Mother
Guardian	Other person and relationship

be signed by the volunteer (if the volunteer is a minor, a parent or guardian must sign) prior to his participation in the sample collections.

Each volunteer should be given sample containers for collection of two 24-hour urine and fecal samples. He should be told that there are no restrictions on food or drink during the test. It is suggested that these containers be given out in a paper shopping bag. An instruction sheet should be included in the bag. The sample containers should be pre-labeled with the volunteer's name and a coded number for the volunteer and for sample identification. A portable toilet with disposable plastic bags should be provided to each family of volunteers for assistance in collection of fecal samples. Experience has shown that these portable toilets will improve the chances of collecting authentic 24-hour fecal samples. The volunteers should be instructed not to contaminate their samples of urine with feces, tap water, etc. Similarly, feces samples should also not include contamination.

The volunteers should begin collection of the first 24-hour urine and feces samples upon arising the next morning. Collection should continue until the following morning in the containers labeled "Sample 1". It should be stressed that all of the urine and feces eliminated during this period should be collected. At that time, collection of the second set of urine and feces samples should begin (use containers marked "Sample 2"). Collected samples should be delivered to the Project Team as soon as possible. As the samples are received, they should be logged in. Each volunteer will be paid upon receipt of all his sample collections.

APPENDIX B

Volunteer's Informed Consent Form

SOUTHWEST RESEARCH INSTITUTE

8500 CULEBRA ROAD • POST OFFICE DRAWER 28510 • SAN ANTONIO, TEXAS 78284

VOLUNTEER'S INFORMED CONSENT

I, ____

residing at ______________________________________

____

hereby acknowledge and certify to the following:

1. That I hereby volunteer and consent to participate as a human test subject in an experiment designed to determine exposure to environmental pollutants entitled, "Study to Determine Distribution of Cadmium in Human Tissue".

2. That I have been given, in my opinion, an adequate explanation of the nature, duration and purpose of the experiment, the means by which the experiment will be conducted and any possible inconveniences, hazards, discomforts, risks, and adverse effects on my health which could result from my participation therein;

3. That I have been informed of all appropriate alternative procedures, if any exist, that might be advantageous to me;

4. That I understand my questions concerning procedures which affect me will be answered fully and promptly;

5. That I understand that I have the right to withdraw my consent and to discontinue participation in this experiment at any time without prejudice regardless of the status of the experiment and regardless of the effect of such withdrawal on the objectives and results which the experiment is designed to achieve; and I also understand that my participation in the experiment may be terminated at any time by the investigator in charge of the project or the physician supervising the project regardless of my wishes to the matter;

6. That I hereby understand and agree that the samples collected from me will be analyzed for their content of trace metals, and that these are the only tests that will be made on these samples and that no medicinal compounds will be analyzed.

over...

7. That I attained the age of ______ years on my last birthday which was ______________________________________, and that I am executing this Volunteer's Informed Consent as my free act and deed.

Executed this _______th day of __________________________, 19____.

Executed in my presence and in
the presence of each other.

______________________________	______________________________
Witness	Volunteer

____
Person informing volunteer and
obtaining volunteer's consent

If subject is a minor, complete the following:
Subject is a minor - age _________.

______________________________	______________________________
Father	Mother
______________________________	______________________________
Guardian	Other person and relationship
	______________________________

APPENDIX C

Justification of Cadmium Questionnaire

A. **Supporting Statement**

1. This new questionnaire is required to obtain information on a population of human volunteers living in a major metropolitan area (Dallas, Texas). The primary objective of this program is to determine body burden levels of cadmium in populations of a major metropolitan area without occupational exposure to cadmium. The project includes the determination of cadmium in tissue samples from autopsy cases and examination of urine and feces from living populations within the area. No forms of this type are currently available within the Environmental Protection Agency or known from other agencies that meet the requirements of this design form. This questionnaire is to be utilized on EPA Contract No. 68-02-1725 entitled "Study to Determine the Distribution of Cadmium in Human Tissue".

It has been shown that the levels of cadmium in body burdens of populations are related to factors such as age, sex, race, cigarette smoking, certain states of disease, and diet. This questionnaire form would provide the necessary information to assist in the final statistical evaluation of collected data that would guide the EPA in its assessment of potential health effects associated with body burdens of cadmium. This questionnaire will solicit personal information from some 160 individuals living within the study area with regard to age, sex, diseases, smoking habits, occupation, and dietary habits. From the 160 subjects completing the questionnaire, 80 will be selected to provide the following four age groups: 10 years or less, 20-30 years, 40-50 years, and greater than 50 years. Each of these individuals would then be sampled twice for 24-hour samples of urine and feces. These samples would be analyzed for concentrations of cadmium. The mean concentrations of each of the four age groups will be calculated along with standard deviations and confidence limits for the means. Additional statistical correlations will be made to determine the possible relationship between concentrations of cadmium and the covariate information collected on the questionnaire.

This project will be conducted as a contract with SwRI under the technical direction of Dr. Donald E. Johnson. The attached statement from Southwest Research Institute provides more details on the plans for this survey.

2. The data collected using this survey instrument and the follow-up statistical analysis will be utilized by the Environmental Protection Agency to assess the potential health effects associated with body burdens of cadmium.

3. There are some preliminary data in the literature which indicate that parameters such as age, sex, ethnic origin, smoking history, diseases, etc., are associated with body burdens of cadmium. This in-depth survey of human subjects and autopsy samples will provide more definitive information about these relationships.

B. Description of Survey Plan

1. The survey is designed to determine the body burdens of cadmium in urine and feces of populations living within the metropolitan area of Dallas, Texas. Four age groups are to be studied with the intent to correlate the levels of cadmium found in certain age groups of white males. This information will also be used for comparison with the information collected via the autopsy examinations.

2. Contacts will be made within the Dallas, Texas, area with emphasis on medical schools or major hospitals for solicitation of white male volunteers. It is anticipated that employees of these types of institution will have some knowledge of medical procedures; thus, they should be able to collect authentic 24-hour specimens. Arrangements will be made to advertise the study by announcement at staff meetings, etc., and by posting information on bulletin boards. This information will include a brief description of the objectives of the study, types and number of volunteers needed, and the time and location of an orientation meeting. At this orientation meeting, each volunteer will be asked to complete the questionnaire. It is anticipated that at least 160 subjects will be required to complete the original questionnaire such that four age groups can be selected. Each subject will be sent a letter announcing that they have been selected or rejected for the survey, and a time and place will be specified as to when those

selected should report for a meeting and for sampling dates. Each subject will be paid $20 for his participation in the study.

A pre-test of the questionnaires has been conducted. This pre-test was conducted with five representative individuals from the staff of Southwest Research Institute, and no difficulty was encountered. The question of non-respondents for this particular survey does not appear to represent a problem since the burden for the individuals to respond to this request is minimal and the number of respondents is expected to be very low. Preliminary contact with representatives of this community indicates that this type of response will be obtained.

3. The statistical design of this project will come primarily from Mr. David Camann with Southwest Research Institute. The EPA statistician, ________________________________, has reviewed this protocol.

4. Name of the contractor: Southwest Research Institute, Contractor's role: The primary role is to collect information and provide a final report to include statistical evaluation of data and conclusions regarding the relationship of covariate information and body burdens of cadmium.

Southwest Research Institute guarantees confidentiality of the collected data to the subject surveyed. No direct reference to the collected data using the subject's name or address will be made.

The subject's name and address will be maintained in a confidential file and will not be directly related to any collected data. Each subject surveyed will be assigned a code number and the coded number with the individual's name will be maintained only in the files of Dr. Donald E. Johnson, principal investigator at Southwest Research Institute.

C. Time Schedule for Data Collection and Publication

The contract is scheduled for two-year completion including monthly reports followed by a comprehensive final report to be submitted on completion of the two-year study. It is estimated that the elapsed time between the completion of data collection and the issuance of the first published reports will be approximately one year.

D. Consultations Outside the Agency

E. Estimation of Respondent Reporting Burden

The estimation of respondent reporting burden for this questionnaire is five minutes. This estimate is based on a preliminary pre-test survey of randomly selected Southwest Research Institute employees.

F. Sensitive Questions

Note: The cadmium questionnaire should have the questions numbered so that we can refer to them. Questions 1 through 3 provide background information on individuals necessary for correlation of variables with regard to cadmium. Questions 4, 5, 6, 7,and 8 are in reference to the subject's occupation. This information is required since certain occupations can contribute to the body burdens of cadmium. Question 8 asks for length of residence in study area. This is necessary for the study in order to relate the body burdens of cadmium with the particular metropolitan area. Ideally, the subject will have spent a major portion of his life within this metropolitan area. Questions 9, 10, 11, 12, and 13 refer to the smoking habits of the individual. It has been shown that cigarette smoking does provide a portion of the cadmium intake and will affect body burdens. Question 14 asks about chronic illnesses. It is necessary to obtain information regarding chronic illnesses in order to provide an assessment of the type of population being surveyed, with comparison to populations in other areas of the country, and, in addition, it is necessary since other studies have indicated that certain chronic diseases such as hypertension will affect body burdens of cadmium. Questions 15,16, and 17 refer to the dietary habits of the individual. It has been shown that the major source of cadmium for an individual originates from food, and it is also shown that certain foods such as liver and kidney (organ foods) and shellfish can contain significantly higher levels of cadmium than do other types of foods. These questions are designed to determine whether or not the individuals derive a significant portion of their diet from these sources of food.

APPENDIX D

International Cd Study Group's Collaborative Test Results

RICE SAMPLES μg/g

	A	B	C	D	E	F	G	H	I	J
Laboratory 1	0.15	0.14	0.055	0.058	0.11	0.058	0.24	0.11	0.74	0.45
Laboratory 2	0.43	0.31	0.19	0.46	0.24	0.21	0.35	0.38	0.96	0.64
Laboratory 3	0.132	0.126	0.052	0.064	0.105	0.044	0.203	0.142	0.642	0.425
Laboratory 4	0.175	0.154	0.068	0.08	0.138	0.073	0.292	0.148	0.88	0.572
Laboratory 6	0.1016	0.0886	0.0369	0.0152	0.0754	0.0335	0.1579	0.0744	0.4265	0.2543
Laboratory 7	0.177	0.142	0.055	0.055	0.105	0.05	0.235	0.125	0.675	0.487
Laboratory 11										
Laboratory 13	0.182		0.048		0.11	0.056		0.173		0.52
Laboratory 18	0.103	0.117	0.036	0.046	0.083	0.042	0.191	0.103	0.793	0.337
Laboratory 19										

METHODS USED

Flame AAS: Laboratory 1

AAS______Laboratories 2 - 4 (after DDTC-MIBK extraction)-6

FECES SAMPLES µg/g

	A	B	C	D	E	F				
Laboratory 1	0.56 0.44 0.20	0.53 0.52 0.21	0.77	0.38 0.52 0.27	1.65 0.64 0.42	0.45 0.48 0.38				
Laboratory 3	0.352	0.27	1.22	0.5	0.502	0.387				
Laboratory 6	0.4641	0.2752	0.7064	0.4124	0.6242	0.5115				
Laboratory 7	0.52	0.65	0.71	0.42	0.36	0.74				
Laboratory 12	0.45	0.45	0.72	0.46	0.48	0.52				
Laboratory 13		0.54	0.79	0.55	0.56	0.47				
Laboratory 14										
Laboratory 18	0.41	0.54	1.11	0.37	0.45	0.44				

METHODS USED

Flame AAS ______ Laboratory 1

AAS ____________ Laboratory 6

Flameless AAS __ Laboratory 12

LIVER SAMPLES μg/g

	A	B	C	D	E	F	G	H	I	J
Laboratory 1	1.5	10.3	5.8 3.4	3.9	3.2	7.6	4.0	5.0	5.8 3.4	4.0
Laboratory 2	1.39	9.03	5.42	3.46	3.09	6.79	3.78	4.75	3.34	3.48
Laboratory 6	0.883	8.565	6.336	4.289	2.75	8.233	3.88	5.284	3.133	3.927
Laboratory 7	0.67	8.8	3.75	3.36	2.66	7.66	3.54	4.05	2.47	3.43
Laboratory 13	1.57	10.8	6.1	3.9	3.5	7.6	4.4	6.0	4.1	4.8
Laboratory 17 x xx	1.44 1.52	10.16 10.69	5.73 6.09	3.70 3.89	3.05 3.20	7.25 7.69	3.70 3.98	5.10 5.30	3.43 3.60	3.53 3.71
Laboratory 18	1.36	10.1	4.64	3.52	2.78	7.11	3.31	5.66	3.05	3.05

METHODS USED

Flame AAS: Laboratory 1

AAS ______ Laboratories 2-6-17 (x) wet
(xx) dry

WHEAT SAMPLES μg/g

(	A	B	C	D	E					
Laboratory 1	3.1	0.13	0.090	0.04	0.095					
Laboratory 2	2.61		0.107	0.077	0.116					
Laboratory 3	2.74	0.105	0.064	0.034	0.075					
Laboratory 4	3.35	0.112	0.072	0.035	0.077					
Laboratory 6	1.2549	0.0412	0.0268	0.0179	0.0354					
Laboratory 7	0.478	0.147	0.091	0.035	0.092					
Laboratory 11										
Laboratory 13	2.54			0.037	0.084					
Laboratory 18	3.09	0.096	0.063	0.036	0.052					
Laboratory 19										

METHODS USED

Flame AAS ______________________ Laboratory 1

AAS ______________________________ Laboratories 2-6

AAS after DDTC-MIBK extraction: Laboratory 4

WHEAT-FLOUR SAMPLES μg/g

	A	B	C	D	E					
Laboratory 1	0.035	0.024	0.046	0.054	0.049					
Laboratory 2	0.057	0.018	0.082	0.073	0.069					
Laboratory 3	0.037	0.021	0.04	0.04	0.05					
Laboratory 4	0.044	0.017	0.039	0.042	0.042					
Laboratory 6	0.0508	0.0325	0.0565	0.0564	0.0533					
Laboratory 7	0.016	0.005	0.047	0.039	0.132					
Laboratory 11										
Laboratory 13	0.029	0.018	0.042	0.041	0.043					
Laboratory 18	0.024	0.014	0.037	0.018	0.024					
Laboratory 19										

METHODS USED

Flame AAS: Laboratory 1

AAS ______laboratories 2 - 4 (after DDCT-HIBK extration) - 6

URINE SAMPLES μg/l

	A	B	C	D	E	F	G	H		
Laboratory 1	0.79	0.53	0.35	0.44	0.63	0.68	0.36	0.29		
Laboratory 2	1.0	0.7	0.7	0.6	1.1	1.0	0.6	0.5		
Laboratory 4	0.5	0.5	0.4	0.3	0.5	0.7	0.3	0.3		
Laboratory 6	0.6	0.5	0.1	0.9	0.9	0.9	0.7	0.2		
Laboratory 10 xxxx	0.53 0.48	1.10 0.85	1.4 1.0	0.49 0.44	1.5 1.1	0.8 0.5	1.4 0.93	2.1 2.0		
Laboratory 10 xx	0.78	0.5 0.8	0.38	0.35	0.7	0.65	0.42	0.35 0.30		
Laboratory 13	<0.5	<0.9	<0.8	<1		<0.7		<0.8		
Laboratory 14	16	5	6	12	<8	<4	12	<4		
Laboratory 18	0.5	0.5	0.3	0.46	0.57	0.62	0.32	0.33		
Laboratory 19										
Laboratory 20 x xxx	0.68 0.63	0.77 0.59	0.44 0.27	0.23 0.33	1,01 0.56	0.85 0.60	0.99 0.30	0.37 0.30		
Laboratory 21	4.7	6	7.2	6.85	3.95	3.9	4.3	3.7		
Laboratory 22	0.78	0.72	0.54	0.72	0.63	0.69	0.66	0.50		

METHODS USED

Flame AAS ______ Lab. 1 - [illegible]

AAS ______ Lab. 2-6-10 (xx) - 22

Flameless AAS (D2 corrector) ______ Lab. 20 (xxx)

HGA determination after dithhizone-chloroform: Lab. 4
extration

Pulse polarography ______ Lab. 10 (xxxx)

BLOOD SAMPLES µg/100 ml

	A	B	C	D	E	F	G	H		
Laboratory 1	0.28	0.32	0.14	0.33	0.044	0.19	0.46	0.19		
Laboratory 6	not determined	0.079	0.055	0.122	not determined	0.041	0.181	0.146		
Laboratory 7	0.185	0.195	0.195	0.485	0.085	0.195	0.46	0.435		
Laboratory 9	0.05	0.2	0.1	0.2	0.1	0.05	0.35	0.2		
Laboratory xxxx 10 xx	0.17 0.2	0.29 0.33	0.19 0.18	0.68 0.89	0.14 0.13	0.08	0.31 0.38	0.33 0.43		
Laboratory 10	0.08 0.23	0.26	0.23	0.66	0.2	0.09 0.14	0.39	0.48 0.32		
Laboratory 13	≦0.06	0.2	≦0.06	≦0.08	≦0.05	0.02	0.3	≦0.11		
Laboratory 14	0.31	0.33	0.31	0.42	0.22	0.38	0.50	0.46		
Laboratory 15	0.03	0.15	0.07	0.13	0.03	0.04	0.29	0.16		
Laboratory 18	0.08	0.16	0.05	0.2	0.04	0.04	0.24	0.2		
Laboratory xx 20 x	lost 0.016	0.58 0.154	0.37 0.068	0.40 0.086	0.36 0.023	0.73 0.050	0.58 0.259	0.38 0.122		
Laboratory 21	0.10	0.20	0.15	0.20	0.15	0.10	0.225	0.225		
Laboratory 22	0.08	0.53	0.50	0.60 0.73	0.27	0.25	0.50	0.25		

METHODS USED

Flame AAS	Lab. 1 - 15 - 20 (x)
AAS	Lab. 6 - 10 (xx) - 22
Flameless AAS	Lab. 20 (xx)
Pulse polarography:	Lab. 10 (xxxx)

AQUEOUS SAMPLES Cd /ug/1

	1	2	3	4	5	6	7	8	9	10
Laboratory 1	-	not detected	trace	20	40	90	80	130	170	180
Laboratory 2	20	20	30	30	60	110	120	150	170	190
Laboratory 3	0	(*)	20	20	49	95	(*)	154	(*)	(*)
Laboratory 4	16	15	26	25	50	105	100	140	165	185
Laboratory 6	12	16.6	24	23.1	53.5	88.4	98.7	127.5	141.9	158.3
Laboratory 7	11	12	20	21	50	92	93	159	102	211
Laboratory 9	10	10	20	20	50	98	92	114	184	200
Laboratory 10 xxxx	11 11	9.5 9.0	17.4 13;13.5	21 18	46 37; 40	99 97	104;104 127	143 129;130	118 133	168 155
Laboratory 10 xx	13 18	17 14	21	28 35	55; 62 78; 72	120;126	116;122 132	157 138	161;187 176	180 172
Laboratory 11	8	10	19	21	50	115	132	165	190	220
Laboratory 12	28	41	19	18	51	110	88	125	145	185
Laboratory 13	11	10	22		46					152
Laboratory 14	18	9	22	22	54	118	100	153	166	177
Laboratory 15	20	10	30	30	60	120	130	170	200	220
Laboratory 17	11.2	11.2	21.8	21.7	52.4	101	105	147	166	179
Laboratory 18	11	11	23	20	52	100	90	139	158	176
Laboratory 19			19	18			101		152	
Laboratory 20 x xxx	9.6 9.9	13.9 10.2	23.1 20.9	20.3 20.8	48.6 61.5	101.7 114.0	94.6 101.7	137.1 100	159.0 160.0	174.6 180.0
Laboratory 21	10.5	6.6	14.75	21.65	50.00 44.25	122.5	121	90	200	180
Laboratory 22	10	11	23	20	10	68		136	200 (180)	140

(*) Damaged by transport

METHODS USED

Flame AAS : Lab. 1-15-20 (x)

AAS : Lab. 2-4-6-10 (xx)
22 x Direct determination
(x) Deter. after extraction

Flameless AAS : Lab. 12-20 (xxx)

Pulse polarography: Lab. 10 (xxxx)

Anodic stripping voltametry : Lab. 10
(Hanging mercury)

AQUEOUS SAMPLES Cd ,ug/l

	11	12	13	14	15	16	17	18	19	20
Laboratory 1	not detected	trace	60	75	80	110	130	160	140	190
Laboratory 2	10	40	70	75	105	120	130	150	160	200
Laboratory 3	4	(*)	(*)	(*)	(*)	108	121	149	(*)	179
Laboratory 4	10	26	70	80	100	110	112	150	150	200
Laboratory 6	6.5	27.7	63.7	74	80.2	86.3	115.1	135.7	115.1	197.4
Laboratory 7	6	26	58	84	93	117	127	159	145	215
Laboratory 9	2.0	26	82	82	98	110	172	188	172	196
Laboratory 10 xxxx	22 ** 27	22 24	63 68	69 83;78	67;106 ** 52;111 **	128 113	123 108	143 142	115 113	172 184
Laboratory 10 xx	7; 27** 7	40 35	102;91	83	125 ** 130 **	126;142 166	156;143 168	188 136	154;177	214 224
Laboratory 11	5	22	80	102	115	135	150	180	170	235
Laboratory 12	5	42	66	68	106	96	108	125	130	190
Laboratory 13			71	71	81		120	152	134	192
Laboratory 14	0	15	57	84	90	120	124	126	136	183
Laboratory 15	10	30	90	100	110	140	150	180	180	230
Laboratory 17	6	26.2	70.8	81.5	92.8	108	125	150	148	202
Laboratory 18	6	27	70	76	89	109	121	147	147	192
Laboratory 19		23	61	73			109	135	180	196
Laboratory 20 x xxx	6.8 5.1	28.1 24.2	67.0 76.5	82.6 80.5	97.4 95.2	109.5 108.5	120.1 107.0	154.1 134.0	143.5 146.0	191.6 202.0
Laboratory 21	3.5	18.5	60	100	50	120.5	142.5	159	147.5	185.5
Laboratory 22	5 (6)	21	64	93	80	100	110	124	138	(200)

(*) Damaged by transport **contaminated

METHODS USED

Flame AAS : Lab. 1-15-20 (x)

AAS : Lab. 2-4-6-10 (xx)-17

22 x Direct determination

(x) Det. after extraction

Flameless AAS : Lab. 12-20 (xxx)

Pulse polarography : Lab. 10 (xxxx)

Anodic stripping voltametry Lab. 10 (hanging mercury)

AQUEOUS SAMPLES Cu µg/l

	21	22	23	24	25	26	27	28	29	30
Laboratory 1	trace	20	70	150	160	not detected	35	55	150	150
Laboratory 2	10	30	90	160	215	10	35	90	155	210
Laboratory 3	8	32	80	(*)	200	10	25	74	153	190
Laboratory 4	12	35	90	160	216	10	30	85	160	200
Laboratory 6	14.8	32.3	78.1	131.6	189.1	10.2	32.2	84.3	143.9	195.3
Laboratory 7	8	29	61	157	204	10	25	69	146	193
Laboratory 9	8.0	40	88	188	200	10	34	92	182	200
Laboratory 10 xxxx	9.2 10	30 32	100 81	170 173;178	218 194	9.5 8	35	112;106 73; 72	216 196	210 183
Laboratory 10 xx	12.5 12	37 44	105 91	179;169 154	263;240 226	13 18	33 36	115 140	176 200	255 208
Laboratory 11	4	10	88	152	210	4	17	85	162	209
Laboratory 12	10	31	76	180	210	13	28	80	140	165
Laboratory 13	10	34	76	141	208					
Laboratory 14	14	35	73	162	217	18	38	88	121	214
Laboratory 15	20	50	110	190	250	30	50	110	200	260
Laboratory 17	11.5	33.2	80.5	158	208	11.8	32.5	76	153	207
Laboratory 18	8	30	80	154	205	9	31	81	155	204
Laboratory 19		28		110	182	10	26	75	146	
Laboratory 20 x xxx	15.3 7.5	34.4 20.2	85.4 70.1	152.0 125.0	206.5 170.0	14.6 6.6	41.5 20.3	84 55.5	159 132	206.5 163
Laboratory 21	10	5.25	110	165	142.5	10.25	30	70	180	160
Laboratory 22	10	22		124	144	8 (4)	30	64 (97)	100	150

(*) Damaged by transport

METHODS USED

Flame AAS : Lab. 1-15-20 (x)

AAS : Lab. 2-4 (after DDTC-MIBK extraction)
6-10-17
22 x Direct determination
(x) Det. after extraction

Flameless AAS : Lab. 12-20 (xxx)

Pulse polarography: Lab. 10 (xxxx)

Anodic stripping voltametry Lab. 10
(hanging mercury)

AQUEOUS SAMPLES µg/l

	31	32	33	34	35	36	37	38	39	40.
oratory 1	trace	trace	35	90	140	not detected	35	75	120	.50
Laboratory 2	0	10	40	95	165	15	35	95	160	210
Laboratory 3	0	(x)	25	82	158	118	34	(x)	140	192
Laboratory 4	< 2	20	40	95	170	31	50	108	170	215
Laboratory 6	0	12	35.1	84.3	148	10.2	33.2	78.1	141.9	199.4
Laboratory 7	1	15	33	87	162	12	28	76	147	217
Laboratory 9	Nil	10	32	90	188	6.0	32	88	182	204
Laboratory 10 xxxx	erre- neous	12 13.5	39 34	71 70	151 130;136	11.2 11.5	31; 32	78 78	118 169;162	166 180;18
Laboratory 10 xx	results	13 16	37 43	134 160	161 145	14.8	47	77 85	188;198 159	206;22 256
Laboratory 11	0	8	24	60	164	9	23	64	156	208
Laboratory 12	N.D.	9	45	112	145	10	27	82	140	200
Laboratory 13	< 0.8		31				32	87	132	175
Laboratory 14	12	21	35	74	153	31	44	100	166	210
Laboratory 15	20	20	50	110	200	30	50	110	190	260
Laboratory 17	< 1	13.1	33.7	80.8	153	11.6	31.6	80.8	145	192
Laboratory 18	≤ 0.4	9	32	75	162	11	29	78	154	205
Laboratory 19				66		10	29		139	187
Laboratory 20 x xxx	6.8 0	21.7 12.4	41.5 30.4	93.2 84	161.2 180	29.5 10.1	47.2 32.3	93.9 90	166.1 160	212.1 221.0
Laboratory 21	2.2	11.3	24.5	105	175	13.5	23.75	92.5	185	230
oratory 22	2 (4)	(14)	20 (25)	54 (50)	120	not detectable (8)	20 (19.5)	80	120	170

(x) Damaged by transport

METHODS USED

Flame AAS : Lab. 1-15-20 (x)

AAS : Lab. 2-4 (after DDTC-MIBK extraction)
6-10-17
22 x direct determination
(x) deter. after extraction

Flameless AAS ; Lab. 12-20 (xxx)

Pulse polarography: Lab. 10 (xxxx)

Anodic stripping voltametry Lab. 10
(hanging mercury)

APPENDIX E

SwRI's Cd Data and Methodologies Submitted to International Cd Study Group Collaborative Test

CADMIUM ANALYSIS: FECES Lab #6

SAMPLE NO.	ANAL. 1 μg/g	ANAL. 2 μg/g	ANAL. 3 μg/g	MEAN μg/g	STD. DEV. μg/g	C. V. %
F06	0.9044	0.4138	0.8070	0.7084	0.2597	36.66
F16	0.2062	0.3447	0.2748	0.2752	0.0693	25.18
F51	0.4202	0.3842	0.4327	0.4124	0.0252	6.11
F80	0.7647	0.2097	0.5600	0.5115	0.2807	54.88
F83	0.6108	0.5945	0.6674	0.6242	0.0383	6.14
F97	0.6716	0.4834	0.2373	0.4641	0.2178	46.93

1. Procedure: 0.5 grams of the feces was digested in 10 ml of HNO_3 and 1 ml of $HClO_4$, filtered, then brought up to a total volume of 50 ml.

2. Analysis: A 10 ml aliquot of the digest solution was adjusted to pH 7.0 with NaOH; 1 ml of NDDC (2%) was added and the Cd extracted into 1 ml of MIBK.
   The organic solvent was aspirated into an air/acetylene flame to determine the Cd concentration.

CADMIUM ANALYSIS: LIVER Lab #6

SAMPLE NO.	ANAL. 1 µg/g	ANAL. 2 µg/g	MEAN µg/g	STD. DEV. µg/g	C.V. %
L01	8.452	8.678	8.565	0.160	1.87
L16	3.845	4.009	3.927	0.116	2.95
L29	2.597	2.902	2.750	0.216	7.85
L32	6.426	6.246	6.336	0.127	2.01
L42	2.893	4.867	3.880	1.396	35.98
L56	4.288	4.290	4.289	0.002	0.04
L68	0.883	0.882	0.883	0.000	0.01
L70	5.593	4.975	5.284	0.437	8.28
L85	3.189	3.077	3.133	0.079	2.53
L99	8.944	7.522	8.233	1.005	12.21

1. Procedure: 0.5 grams of the liver sample was digested in 10 ml of HNO_3 and 1 ml of $HClO_4$, filtered, then brought up to a total volume of 100 ml.

2. Analysis: A 10 ml aliquot of the digest solution was adjusted to pH 7.0 with NaOH; 1 ml of NDDC (2%) was added and the Cd extracted into 1 ml of MIBK
The organic solvent was aspirated into an air/acetylene flame to determine the Cd Concentration.

CADMIUM ANALYSIS: FLOUR Lab #6

SAMPLE No.	ANAL. 1 µg/g	ANAL. 2 µg/g	MEAN µg/g	STD. DEV. µg/g	C.V. %
WF37	0.0565	0.0563	0.0564	0.0001	0.24
WF52	0.0299	0.0350	0.0325	0.0035	10.93
WF68	0.0567	0.0564	0.0565	0.0002	0.32
WF87	0.0500	0.0566	0.0533	0.0047	8.83
WF95	0.0450	0.0567	0.0508	0.0083	16.28

1. Procedure: 3 grams of flour was digested with 10 ml conc. HNO_3 and 1 ml of $HClO_4$, filtered , then brought up to a total volume of 25 ml.

2. Analysis: A 10 ml aliquot of the digest solution was adjusted to pH 7.0 with NaOH; 1 ml of NDDC (2%) was added and the Cd extracted into 1 ml of MIBK.
   The organic solvent was aspirated into an air/acetylene flame to determine the Cd concentration.

CADMIUM ANALYSIS: URINE Lab #6

SAMPLE NO.	ANAL. 1 µg/ml	ANAL. 2 µg/ml	MEAN µg/ml	STD. DEV. µg/ml	C.V. %
U02	0.0007	0.0005	0.0006	0.0002	36.0
U03	0.0001	0.0002	0.0001	0.0001	66.0
U13	0.0006	0.0005	0.0005	0.0002	33.6
U46	0.0009	0.0010	0.0009	0.0004	40.0
U49	0.0004	0.0001	0.0002	0.0002	88.2
U63	0.0005	0.0008	0.0007	0.0005	77.1
U77	0.0009	0.0010	0.0009	0.0004	40.0
U88	0.0007	0.0011	0.0009	0.0005	50.2

1. Procedure: 10 ml of urine was extracted using a NDDC (2%)/ Triton X-100 (1%) solution and 1 ml of MIBK.

2. Analysis; The organic extract was analyzed for Cd by injecting into a graphite tube furnace .

3. Notes: The urine samples were all at pH 7.0 when received. There was a fine precipitate in all the samples.

CADMIUM ANALYSIS: RICE Lab #6

SAMPLE NO.	ANAL. 1 µg/g	ANAL. 2 µg/g	MEAN µg/g	STD. DEV. µg/g	C. V. %
R08	0.0606	0.0882	0.0744	0.0195	26.21
R09	0.0135	0.0168	0.0152	0.0023	15.13
R20	0.0931	0.0840	0.0886	0.0064	7.22
R27	0.2266	0.2820	0.2543	0.0392	15.41
R29	0.0350	0.0319	0.0335	0.0022	6.57
R47	0.0366	0.0372	0.0369	0.0004	1.08
R56	0.0655	0.0852	0.0754	0.0139	18.44
R64	0.0936	0.1095	0.1016	0.0112	11.02
R68	0.1485	0.1672	0.1579	0.0132	8.36
R78	0.3920	0.4610	0.4265	0.0488	11.44

1. Procedure: Approximately 3 grams of rice was leached for 25-28 hrs. with 10 ml of 1% HNO_3.

2. Analysis: A 10 ml aliquot of the leach solution (1% HNO_3) was adjusted to pH 7.0 with NaOH and NDDC (2%) added. The Cd-NDDC complex was extracted into 1 ml of MIBK. s
The organic solvent was aspirated into an air/acetylene flame to determine Cd.

CADMIUM ANALYSIS: WHEAT Lab #6

SAMPLE N.O.	ANAL. 1 µg/g	ANAL. 2 µg/g	MEAN µg/g	STD. DEV. µg/g	C.V. %
W11	0.0356	0.0468	0.0412	0.0079	19.17
W15	0.0394	0.0313	0.0354	0.0057	16.10
W68	0.0164	0.0194	0.0179	0.0021	11.73
W72	0.0239	0.0297	0.0268	0.0041	15.30
W96	1.1616	1.3482	1.2549	0.1319	10.51

1. Procedure: Approximately 3 grams of wheat was leached for 25-28 hr. with 10 ml of 1% HNO_3

2. Analysis: A 5 ml aliquot of the leach solution (1% HNO_3) was adjusted to pH 7.0 with NaOH and NDDC (1%) added. The Cd - NDDC complex was extracted into 1 ml of MIBK.
The organic solvent was aspirated into an air/acetylene flame to determine Cd.

CADMIUM ANALYSIS: WATER

Lab #6

SAMPLE NO.	CONCENTRATION μg/ml
1	0.0843
2	0.0148
3	0.1151
5	0.0802
6	0.0277
7	0.1419
10	0.0231
11	0.0863
13	0.0740
18	0.0166
20	0.0535
21	0.0637
25	0.0120
27	0.0102
28	0.1974
31	0.1275
32	0.0323
35	0.1439
37	0.0240
42	0.1419
44	0.1891
48	0.1357
49	0.1316
55	0.0332
58	0.0332
59	0.0120
64	0.1953
65	0.1994
66	0.0884
67	0.0351
68	0.1480
69	0.1151
71	0.0065
74	0.1583
75	0.0843
82	0.0102
83	0.0000
86	0.0987
92	0.0781
98	0.0781

Water samples were extracted using NDDC (1%) and MIBK. The organic solvent was aspirated into an air/acetylene flame.

CADMIUM ANALYSIS: BLOOD Lab #6

SAMPLE NO.	CONCENTRATION µg/100 ml
B 10	0.146
B 27	0.055
B29	0.122
B 31	0.181
B 35	0.079
B 48	N. D.*
B 69	N. D.*
B 87	0.041

*N. D. - below the detection limit of the procedure

1. Procedure: 2 ml of whole blood is hemolyzed and chelated with 0.7 ml of NDDC (2%) / Triton X-100 (1%) solution and the Cd is extracted into MIBK.

2. Analysis: Organic solvent (MIBK) containing Cd is injected into a graphite tube furnace.

Instrumentation:

All analyses were performed on a Perkin-Elmer Atomic Absorption Spectrophotometer Model 306. A Deuterium Arc Background Corrector was utilized to reduce background absorption. Peak heights were recorded on a Perkin-Elmer Recorder Model 056.

Samples were either aspirated into an air/acetylene flame or analyzed with a Perkin-Elmer HGA-200 Graphite Tube Furnace.

Reagents:

(1) HNO_3 and $HClO_4$ acids were Suprapur Quality.

(2) NDDC (Diethyldithiocarbamic Acid Sodium Salt) from Eastman Organic Chemicals, Stock No. 2596.

(3) MIBK (Methyl Isobutyl Ketone) from Eastman Organic Chemicals, Stock No. 13033.

(4) All water used in sample preparation was deionized.

APPENDIX F

AUTOPSY TISSUE CADMIUM RAW DATA

CADMIUM CONCENTRATIONS IN MUSCLE TISSUE, μg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group 10-19 (Mean 0.0315)		
1674-74	0.0224	0.1120
1840-74	0.1120	0.1120
1924-74	0.0437	0.0358
* 1990-74	0.0246	0.0280
* 2137-74	0.0246	<0.0213
* 2223-74	0.0280	0.0258
* 2327-74	0.0392	0.0280
2398-74	0.0627	0.0560
2408-74	0.0381	<0.0213
2499-74	0.0526	0.0538
2521-74	<0.0213	<0.0213
* 2576-74	0.0773	0.0885
* 2-75	0.0280	0.0224
183-75	0.0459	0.0302
225-75	<0.0213	<0.0213
368-75	<0.0213	<0.0213
671-75	0.0213	0.0291
* 688-75	0.0235	<0.0213
* 886-75	0.0224	<0.0213
* 1138-75	0.0302	<0.0213
* 1224-75	0.0269	0.0358
1265-75	0.0269	0.0246
* 1312-75	0.0302	0.0392
1317-75	<0.0213	<0.0213
* 1402-75	0.0560	0.0426
* 1505-75	0.0829	0.0862
* 1570-75	<0.0213	<0.0213
* 1571-75	<0.0213	<0.0213
* 1679-75	<0.0213	0.0235
* 1689-75	<0.0213	<0.0213
1876-75	<0.0213	<0.0213
1975-75	0.0224	0.0235
* 1995-75	0.0235	0.0213
Age Group 20-29 (Mean 0.0544)		
1564-74	0.0683	0.0851
* 1671-74	0.0806	0.0661
1716-74	0.0806	0.1019
* 1785-74	0.0235	0.0269
1828-74	0.1120	0.1120
* 1836-74	0.0504	0.0448
1861-74	0.1120	0.1120
* 1888-74	0.1120	0.1120
* 1903-74	0.448	0.0638
1923-74	0.0280	0.0291

Autopsy No.	Concentration	
	1	2
Age Group 20-29 (Mean 0.0544) (Cont'd)		
* 1936-74	0.0358	0.0235
* 1989-74	0.1042	0.0862
* 2190-74	0.0302	0.0246
* 2201-74	0.0269	0.0370
* 2261-74	0.0482	0.0526
* 2313-74	0.0336	0.0582
* 2376-74	0.0829	0.0885
2419-74	0.0414	0.0616
2431-74	0.0694	0.0515
2563-74	0.1008	0.0896
* 2577-74	0.0706	0.0739
* 2590-74	0.0594	0.0526
* 104-75	0.0224	<0.0213
* 117-75	0.0280	0.0269
* 218-75	0.0426	0.0246
* 279-75	<0.0213	<0.0213
* 286-75	0.0246	0.0269
* 296-75	0.0426	0.0482
298-75	<0.0213	<0.0213
* 305-75	0.0235	<0.0213
* 324-75	0.1478	0.1557
* 335-75	0.0302	0.0269
* 472-75	<0.0213	<0.0213
548-75	0.0280	0.0482
582-75	0.0627	0.0728
* 601-75	0.0986	0.1411
* 786-75	0.0235	0.0314
* 1272-75	0.0291	0.0347
Age Group 30-39 (Mean–0.0544)		
* 1682-74	0.1243	0.1344
1706-74	0.0246	0.0302
* 1830-74	0.0235	0.0291
* 1900-74	0.0392	0.0414
1978-74	0.0997	0.1030
2059-74	0.0302	0.0235
* 2112-74	0.1501	0.1120
* 2121-74	0.1008	0.1019
2122-74	0.0818	0.0941
* 2132-74	0.1019	0.0941
* 2140-74	0.0403	0.0627
* 2175-74	0.0605	0.0448
2184-74	0.0526	0.0515
* 2220-74	0.0526	0.0571
* 2238-74	0.0549	0.0448

*denotes cigarette smoker.

CADMIUM CONCENTRATIONS IN MUSCLE TISSUE, µg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group 30-39 (Mean--0.0544) (Cont'd)		
2273-74	0.0526	0.0605
* 2401-74	0.0426	0.0370
* 2409-74	0.0650	0.0560
* 60-75	0.0840	0.0627
156-75	<0.0213	<0.0213
257-75	0.0515	0.0459
* 360-75	<0.0213	<0.0213
* 393-75	0.0246	0.0235
* 425-75	0.0291	0.0347
514-75	0.0302	0.0280
* 635-75	0.0493	0.0594
* 677-75	0.0370	0.0381
* 733-75	0.0538	0.0571
* 740-75	0.0672	0.0594
* 753-75	0.0358	0.0470
* 794-75	0.0739	0.0795
* 899-75	0.0426	0.0392
* 1519-75	0.0336	0.0392
Age Group 40-49 (Mean--0.0855)		
* 1565-74	0.0762	0.0739
* 1570-74	0.0448	0.0414
* 1575-74	0.1266	0.1434
* 1634-74	0.0717	0.1064
1647-74	0.1086	0.0594
1773-74	0.0549	0.0661
* 1829-74	0.0829	0.0706
* 1872-74	0.0974	0.1568
* 1972-74	0.1736	0.1344
* 2089-74	0.1702	0.1266
2129-74	0.0414	0.0347
* 2131-74	0.0616	0.0515
* 2143-74	0.0683	0.0616
* 2301-74	0.0549	0.0627
* 2367-74	0.0986	0.0795
* 2379-74	0.2509	0.1378
* 2414-74	0.0795	0.0717
* 2432-74	0.0549	0.0829
* 2469-74	0.0773	0.0773
* 2476-74	0.0605	0.0795
* 2477-74	0.0829	0.1210
2598-74	<0.0213	0.0269
* 184-75	0.0941	0.0851
* 219-75	0.0504	0.0538
* 336- 75	0.0885	0.1131
Age Group 40-49 (Mean-0.0855) (Cont'd)		
* 439-75	0.0851	0.0538
*1335-75	0.0907	0.0907
*1417-75	0.1064	0.0874
Age Group 50-59 (Mean-0.1074)		
*1562-74	0.0952	0.0795
*1694-74	0.1691	0.1915
1696-74	0.0504	0.0885
1742-74	0.1490	0.1400
*1770-74	0.1086	0.1165
*1898-74	0.1243	0.1008
1920-74	0.0358	0.0549
*1945-74	0.0818	0.0851
*1953-74	0.1187	0.1187
*2024-74	0.0851	0.0694
*2031-74	0.1053	0.1400
*2042-74	0.1008	0.0974
*2055-74	0.1658	0.1826
2156-74	0.0874	0.0638
*2170-74	0.0549	0.0784
*2278-74	0.1098	0.1008
*2317-74	0.1814	0.2094
*2334-74	0.1366	0.1232
*2354-74	0.1019	0.1422
2427-74	0.0930	0.1176
*2443-74	0.1075	0.0952
2536-74	0.1243	0.1333
*2578-74	0.1165	0.0818
*2608-74	0.0952	0.0515
1-75	0.0482	0.0280
* 35-75	0.1467	0.1434
43-75	0.0448	0.0336
* 62-75	0.1221	0.1154
* 70-75	0.1042	0.0907
* 71-75	0.0874	0.0829
* 63-76	0.1926	0.1960
Age Group 60+ (Mean 0.7860)		
*2182-74	0.7851	0.7862

CADMIUM CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean 0.8185)		
1674-74	1.0504	1.0706
1840-74	0.7676	1.3837
1924-74	0.4848	0.4747
*1990-74	0.3131	0.1919
*2137-74	1.7372	1.9796
*2223-74	1.3130	1.3231
*2327-74	2.2725	2.1816
2398-74	0.6868	0.6464
2408-74	1.1009	1.4746
2499-74	1.5554	1.5554
2521-74	0.3636	0.3434
*2576-74	1.2322	1.1211
* 2-75	0.2222	0.2424
183-75	0.5959	0.6161
225-75	0.7171	0.8080
368-75	1.5049	1.3534
671-75	<0.1717	<0.1717
* 688-75	1.2019	1.2827
* 886-75	0.9191	0.8181
*1138-75	0.9595	1.5150
*1224-75	0.6868	0.6464
1265-75	0.2121	0.3232
*1312-75	0.3131	0.3737
1317-75	0.4949	0.4040
*1402-75	0.1717	<0.1717
*1505-75	2.1917	2.3634
*1570-75	0.5858	0.7070
*1571-75	0.5353	0.5858
*1679-75	1.2726	1.5655
*1689-75	0.8383	0.7777
1876-75	0.2626	0.2626
1975-75	0.9292	0.9292
*1995-75	1.1514	1.1716
Age Group 20-29 (Mean - 1.0279)		
1564-74	1.1615	1.1312
*1671-74	1.9493	1.8180
1716-74	0.8686	0.8787
*1785-74	1.3332	1.2524
1828-74	1.3231	1.1716
*1836-74	1.1716	0.9595
1861-74	1.1615	1.1615
*1888-74	1.2827	2.0200
*1903-74	0.7272	0.7272
1923-74	1.8483	1.8180

Autopsy No.	Concentration 1	Concentration 2
Age Group 20-29 (Mean- 1.0279) (Cont'd)		
*1936-74	1.1312	1.0504
*1989-74	0.6464	0.6060
*2190-74	1.4847	1.3332
*2201-74	0.9999	0.4141
*2261-74	1.6564	1.6362
*2313-74	2.1008	2.5351
*2376-74	0.9191	1.9897
2419-74	0.6666	0.6363
2431-74	2.0099	1.9897
2563-74	0.8383	0.8383
*2577-74	0.9797	0.9999
*2590-74	0.7474	0.8181
* 104-75	0.5555	0.5959
* 117-75	1.0605	1.3332
* 218-75	2.5149	1.8685
* 279-75	1.3433	1.3029
* 286-75	1.3736	1.4241
* 296-75	2.1513	2.2220
298-75	0.3333	0.3131
* 305-75	0.5757	0.6262
* 324-75	0.4242	0.4848
* 335-75	0.2929	0.4242
* 472-75	0.2121	0.1717
548-75	0.5656	0.6767
582-75	0.9292	0.9494
* 601-75	0.4747	0.3939
* 786-75	0.5151	0.5151
*1272-75	1.4645	0.9595
Age Group 30-39 (Mean - 1.3002)		
*1682-74	1.4342	1.1514
1706-74	0.7373	0.6868
*1830-74	1.4544	1.4342
*1900-74	1.9998	1.7271
1978-74	1.3736	1.4140
2059-74	0.6060	0.5858
*2112-74	3.1714	3.3532
*2121-74	1.9089	1.6867
2122-74	0.9292	1.2019
*2132-74	1.8786	1.5857
*2140-74	0.4848	0.5959
*2175-74	3.4542	2.7371
2184-74	1.2625	1.1716
*2220-74	1.1615	1.1312
*2238-74	2.1816	2.2119

CADMIUM CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group 30-39 (Mean–1.3002) (Cont'd)		
2273-74	1.6463	0.8080
*2401-74	1.1817	1.1918
*2409-74	1.5554	1.3635
* 60-75	2.7876	2.7674
156-75	0.4545	0.3535
257-75	1.7473	1.7877
* 360-75	0.8787	0.7474
* 393-75	0.2323	0.2323
* 425-75	1.1009	0.8080
514-75	0.5555	0.5959
* 635-75	0.8989	0.8181
* 677-75	1.3332	1.1514
* 733-75	1.2221	1.2221
* 740-75	1.9695	2.3735
* 753-75	2.2321	2.4240
* 794-75	2.1513	2.0200
* 899-75	0.9292	1.1817
*1519-75	0.9898	0.6060
Age Group 40-49 (Mean–1.2864)		
*1565-74	0.9696	0.8686
*1570-74	0.4747	0.4444
*1575-74	1.8281	1.8180
*1634-74	1.1615	1.5756
1647-74	1.2625	1.2625
1773-74	1.3534	1.1413
*1829-74	0.8787	2.1008
*1872-74	2.5351	2.7270
*1972-74	1.2423	0.9696
*2089-74	0.5959	0.4949
2129-74	1.1009	1.3029
*2131-74	1.5958	1.6160
*2143-74	1.9998	1.9392
*2301-74	3.7067	3.6461
*2367-74	0.4242	0.4141
*2379-74	2.4442	2.5250
*2414-74	2.1917	2.2220
*2432-74	1.1817	1.3736
*2469-74	1.4039	1.1110
*2476-74	1.2322	1.1211
*2477-74	0.5555	0.5959
2598-74	1.2322	1.2120
* 184-75	0.2929	0.2222
* 219-75	0.5353	0.5757
* 336-75	3.4946	3.6057
Age Group 40-49 (Mean–1.2864) (Cont'd)		
* 439-75	0.8383	1.2120
*1335-75	1.7069	1.0706
*1417-75	0.9696	1.0302
Age Group 50-59 (Mean–0.7900)		
*1562-74	1.7069	1.3029
*1694-74	0.2525	0.3131
1696-74	0.7979	0.8181
1742-74	3.6663	3.2017
*1770-74	1.7776	1.8988
*1898-74	1.7271	1.7271
1920-74	2.9290	1.2120
*1945-74	0.5757	0.6767
*1953-74	0.2727	0.2020
*2024-74	0.3333	0.1919
*2031-74	2.3129	2.3836
*2042-74	2.6563	2.6159
*2055-74	0.9090	0.8282
2156-74	0.4444	0.4848
*2170-74	1.4948	1.4544
*2278-74	1.7069	1.5857
*2317-74	2.1816	2.2018
*2334-74	1.5756	1.5251
*2354-74	1.4948	1.2423
2427-74	2.3129	2.4341
*2443-74	1.1009	1.1312
2536-74	1.0504	0.9393
*2578-74	0.6363	0.6363
*2608-74	0.3030	0.3434
1-75	0.3535	0.3131
* 35-75	1.7170	1.3938
43-75	0.7878	0.9494
* 62-75	0.6262	0.5656
* 70-75	1.7978	1.8584
* 71-75	0.8686	1.4140
* 63-76	2.6866	2.6967
Age Group 60+ (Mean–8.5735)		
*2182-74	7.6154	9.6455

CADMIUM CONCENTRATIONS IN PANCREAS TISSUE, μg/gm wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean 0.3258)		
1674-74	0.3172	0.3172
1840-74	0.2153	0.2153
1924-74	0.4038	0.2853
*1990-74	0.2802	0.2297
*2137-74	0.3821	0.3821
*2223-74	0.3533	0.3533
*2327-74	0.4707	0.3533
2398-74	0.1648	0.1648
2408-74	0.2266	0.2709
2499-74	0.4429	0.5541
2521-74	0.1638	0.1638
*2576-74	0.3502	0.3729
* 2-75	0.4522	0.4295
183-75	0.1926	0.1710
225-75	0.2410	0.1926
368-75	0.4099	0.4367
671-75	0.1566	0.2019
* 688-75	0.3121	0.3121
* 886-75	0.4295	0.4099
*1138-75	0.5346	0.5346
*1224-75	0.5562	0.6005
1265-75	0.2894	0.3141
*1312-75	0.6932	0.6932
1317-75	0.2431	0.2431
*1402-75	0.3646	0.3646
*1505-75	0.4450	0.4892
*1570-75	0.1586	0.1360
*1571-75	0.1813	0.1586
*1679-75	0.4563	0.4563
*1689-75	0.2513	0.2503
1876-75	0.1370	0.1597
1975-75	0.3420	0.3420
*1995-75	0.3770	0.4223
Age Group 20-29 (Mean 0.4191)		
1564-74	0.2935	0.3141
*1671-74	0.6345	0.5892
1716-74	0.2050	0.1823
*1785-74	0.2874	0.2874
1828-74	0.4068	0.4068
*1836-74	0.6077	0.6077
1861-74	0.2369	0.1895
*1888-74	0.3821	0.4058
*1903-74	0.1823	0.1823
1923-74	0.3420	0.3420
Age Group 20-29 (Mean 0.4191) (Cont'd)		
*1936-74	0.6293	0.6705
*1989-74	0.6777	0.6777
*2190-74	0.3389	0.2493
*2201-74	0.5037	0.4800
*2261-74	0.6108	0.4295
*2313-74	0.6510	0.6757
*2376-74	0.5634	0.5912
2419-74	0.3770	0.2585
2431-74	0.6108	0.6788
2563-74	0.2266	0.2493
*2577-74	0.6530	0.5830
*2590-74	0.3636	0.4274
* 104-75	0.3636	0.4707
* 117-75	0.5171	0.5171
* 218-75	0.4892	0.5366
* 279-75	0.3028	0.2802
* 286-75	0.4923	0.4923
* 296-75	0.3729	0.3729
298-75	0.1555	0.1555
* 305-75	0.2668	0.2441
* 324-75	0.8199	0.7416
* 335-75	0.6674	0.6005
* 472-75	0.4882	0.5325
548-75	0.3698	0.3698
582-75	0.3059	0.3059
* 601-75	0.2668	0.2225
* 786-75	0.4666	0.5778
*1272-75	0.2884	0.2884
Age Group 30-39 (Mean 0.5527)		
*1682-74	0.9836	1.1330
1706-74	0.5511	0.4800
*1830-74	0.5511	0.5995
*1900-74	0.4316	0.5263
1978-74	0.4553	0.4789
2059-74	0.3543	0.3543
*2112-74	1.0640	0.9280
*2121-74	0.5511	0.6891
2122-74	0.8497	0.8724
*2132-74	0.5274	0.5511
*2140-74	0.3904	0.4367
*2175-74	0.8961	0.8497
2184-74	0.2390	0.1669
*2220-74	0.8703	0.8240
*2238-74	0.4522	0.4295

CADMIUM CONCENTRATIONS IN PANCREAS TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group 30-39 (Mean–0.5527) (Cont'd)		
2273-74	0.8734	0.8724
*2401-74	0.6293	0.6067
*2409-74	0.5366	0.5830
* 60-75	0.9620	0.9847
156-75	<0.1051	<0.1051
257-75	0.6489	0.6489
* 360-75	0.2122	0.2111
* 393-75	0.2544	0.2338
* 425-75	0.5274	0.4491
514-75	0.2111	0.1885
* 635-75	0.5593	0.5819
* 677-75	0.5006	0.5006
* 733-75	0.6211	0.7550
* 740-75	0.6231	0.6231
* 753-75	0.7560	0.8673
* 794-75	0.6839	0.6839
* 899-75	0.3111	0.3327
*1519-75	0.6571	0.5438
Age Group 40-49 (Mean–0.7807)		
*1565-74	0.7756	0.8436
*1570-74	0.5449	0.6499
*1575-74	0.6293	0.6087
*1634-74	0.7025	0.7251
1647-74	0.4079	0.3399
1773-74	0.9105	0.8621
*1829-74	1.1227	1.4090
*1872-74	0.9579	1.2999
*1972-74	0.7879	0.8116
*2089-74	0.9836	0.9836
2129-74	1.1021	0.9589
*2131-74	0.5057	0.6231
*2143-74	0.8384	0.8384
*2301-74	0.9002	0.9013
*2367-74	0.1885	0.2122
*2379-74	2.0487	1.7644
*2414-74	0.6757	0.6633
*2432-74	0.6994	0.6304
*2469-74	0.5881	0.4975
*2476-74	1.7767	1.7963
*2477-74	0.5830	0.4202
2598-74	0.4666	0.4429
* 184-75	0.5181	0.5171
* 219-75	0.7220	0.7220
* 336-75	1.9519	1.9292
Age Group 40-49 (Mean–0.7807) (Cont'd)		
* 439-75	0.4233	0.3533
*1335-75	0.7014	0.6746
*1417-75	0.6159	0.6159
Age Group 50-59 (Mean 0.7665)		
*1562-74	0.7066	0.7756
*1694-74	0.3399	0.4079
1696-74	0.3626	0.4759
1742-74	1.2226	1.3421
*1770-74	0.9857	0.8178
*1898-74	1.7984	1.7500
1920-74	0.2740	0.2966
*1945-74	0.6211	0.5974
*1953-74	0.8765	1.0475
*2024-74	0.6211	0.6684
*2031-74	1.3256	0.9260
*2042-74	1.1732	1.1732
*2055-74	0.2966	0.3646
2156-74	0.1916	0.1916
*2170-74	1.1464	1.2896
*2278-74	1.1989	1.3802
*2317-74	0.9888	0.8703
*2334-74	0.6262	0.6953
*2354-74	0.8868	0.8868
2427-74	0.9888	0.9651
*2443-74	0.5057	0.4130
2536-74	1.0969	1.0496
*2578-74	0.4429	0.3729
*2608-74	0.4192	0.4429
1-75	0.2688	0.3584
* 35-75	1.2751	1.3648
43-75	0.2462	0.2235
* 62-75	0.7457	0.7457
* 70-75	0.8394	0.8384
* 71-75	1.1958	1.3699
* 63-76	1.2514	1.2803
Age Group 60+ (Mean–4.3122)		
*2182-74	4.2158	4.4146

CADMIUM CONCENTRATIONS IN KIDNEY TISSUE, μg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group 10-19 (Mean 7.6711)		
1674-74	5.8464	6.1264
1840-74	8.6800	8.8592
1924-74	14.6048	15.1200
*1990-74	8.3104	7.9520
*2137-74	4.1664	7.5040
*2223-74	8.8368	9.0048
*2327-74	8.8144	10.3488
2398-74	6.4736	6.8992
2408-74	8.8704	8.7042
2499-74	15.4224	15.5568
2521-74	3.1024	2.8336
*2576-74	7.6944	7.1232
* 2-75	16.1952	16.2848
183-75	3.5616	2.4304
225-75	4.8496	5.4992
368-75	8.7360	8.8144
671-75	2.4752	3.6288
* 688-75	6.3728	6.7312
* 886-75	7.4928	7.9520
*1138-75	16.1616	14.6720
*1224-75	16.6544	17.3152
1265-75	6.1600	6.5296
*1312-75	18.2000	22.5680
1317-75	5.4768	5.5776
*1402-75	5.4768	6.5968
*1505-75	13.3952	15.5344
*1570-75	3.7744	3.7744
*1571-75	3.4496	3.2704
*1679-75	13.0368	10.5616
*1689-75	8.1760	7.4144
1876-75	4.9056	3.3936
1975-75	6.0144	5.9248
*1995-75	8.5904	11.4128
Age Group 20-29 (Mean 12.9852)		
1564-74	10.8528	10.6512
*1671-74	28.3920	29.2656
1716-74	13.9776	14.7056
*1785-74	16.3408	16.9008
1828-74	14.2912	14.2128
*1836-74	26.7680	26.5328
1861-74	7.5936	7.7056
*1888-74	11.8944	12.1632
*1903-74	10.4608	10.4720
1923-74	11.9728	11.8496
Age Group 20-29 (Mean - 12.9852) (Cont'd)		
*1936-74	31.3376	28.2912
*1989-74	18.6368	19.3760
*2190-74	7.7168	7.4480
*2201-74	11.4912	11.6816
*2261-74	24.3376	26.3760
*2313-74	17.8192	12.5776
*2376-74	9.6656	10.7520
2419-74	16.4192	16.4304
2431-74	20.0928	21.2128
2563-74	9.2400	10.9312
*2577-74	25.7824	33.2080
*2590-74	15.0976	18.4352
* 104-75	4.1328	3.7744
* 117-75	9.3632	11.4688
* 218-75	21.6160	22.3440
* 279-75	10.4608	11.5584
* 286-75	14.8624	16.7328
* 296-75	19.4880	20.7872
298-75	4.4016	4.8608
* 305-75	6.3056	5.8240
* 324-75	27.2832	27.7088
* 335-75	21.4816	25.3008
* 472-75	12.5328	10.9984
548-75	7.9632	6.3728
582-75	7.0784	6.8992
* 601-75	14.1568	13.8992
* 786-75	11.8608	15.7584
*1272-75	14.6048	13.5408
Age Group 30-39 (Mean - 22.0116)		
*1682-74	30.1392	29.7248
1706-74	8.0528	7.6720
*1830-74	42.3920	42.3472
*1900-74	33.1072	33.4656
1978-74	20.8768	24.5504
2059-74	12.0400	11.7712
*2112-74	15.3664	17.3488
*2121-74	20.2160	27.9552
2122-74	15.0192	11.8496
*2132-74	48.0368	30.5760
*2140-74	13.9104	22.3216
*2175-74	30.0384	29.1984
2184-74	11.2112	10.7632
*2220-74	50.4560	52.7744
*2238-74	43.1088	42.2576

CADMIUM CONCENTRATIONS IN KIDNEY TISSUE, μg/gm wet weight (Cont'd)

Age Group 30-39 (Mean–22.0116) (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
2273-74	20.4288	17.9200
*2401-74	51.0272	51.6096
*2409-74	39.7376	39.2672
* 60-75	16.6096	28.7840
156-75	8.6688	8.9600
257-75	23.2736	31.8080
* 360-75	7.5264	6.8880
* 393-75	10.1920	9.3632
* 425-75	13.7536	11.0656
514-75	7.8736	14.5152
* 635-75	29.0080	31.6064
* 677-75	18.5136	20.6752
* 733-75	49.7840	47.6336
* 740-75	31.5952	27.2720
* 753-75	18.4352	25.1216
* 794-75	30.9008	28.7504
* 899-75	32.7264	26.7008
*1519-75	20.6752	26.1744

Age Group 40-49 (Mean–25.8966)

Autopsy No.	Concentration 1	Concentration 2
*1565-74	31.4272	33.3984
*1570-74	34.9216	24.7296
*1575-74	27.4736	46.3792
*1634-74	27.6080	40.8352
1647-74	13.4960	13.4960
1773-74	46.3008	35.1344
*1829-74	38.4048	36.2544
*1872-74	49.7840	42.0784
*1972-74	18.7040	26.6112
*2089-74	26.0064	25.4688
2129-74	26.1856	22.3216
*2131-74	15.8032	18.6704
*2143-74	34.4512	34.8992
*2301-74	20.7088	18.4240
*2367-74	25.7376	26.6112
*2379-74	44.4976	44.9456
*2414-74	49.8848	51.1952
*2432-74	27.3504	28.9072
*2469-74	17.3488	19.5104
*2476-74	31.4496	33.6336
*2477-74	37.7664	35.4144
2598-74	3.9536	3.7856
* 184-75	5.3984	9.3520
* 219-75	23.3856	23.8112
* 336-75	57.1424	55.8544

Age Group 40-49 (Mean- 25.8966) (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
* 439-75	12.8240	10.5616
*1335-75	24.8976	38.4384
*1417-75	32.3008	38.7632

Age Group 50-59 (Mean–25.3377)

Autopsy No.	Concentration 1	Concentration 2
*1562-74	25.8832	34.5744
*1694-74	39.7152	32.2784
1696-74	17.1696	24.4272
1742-74	22.6464	31.8640
*1700-74	34.6304	33.5664
*1898-74	108.4720	108.8528
1920-74	15.0080	14.6608
*1945-74	28.3248	33.4768
*1953-74	27.2720	27.2384
*2024-74	27.8992	25.3232
*2031-74	15.5120	14.6720
*2042-74	39.6256	24.9872
*2055-74	21.9856	21.4480
2156-74	11.1328	9.6992
*2170-74	19.2752	16.7440
*2278-74	33.8576	32.2224
*2317-74	41.6416	39.4800
*2334-74	19.7904	17.0800
*2354-74	17.5616	26.1632
2427-74	31.9760	31.5056
*2443-74	36.0192	37.4304
2536-74	16.2064	20.0816
*2578-74	15.0080	12.3536
*2608-74	23.6992	26.8128
1-75	13.5408	12.0288
* 35-75	49.3584	48.9216
43-75	8.3216	8.8480
* 62-75	27.2720	24.2480
* 70-75	30.3184	24.8976
* 71-75	24.8640	22.2544
* 63-76	64.1984	53.7264

Age Group 60+ (Mean–26.1669)

Autopsy No.	Concentration 1	Concentration 2
*2182-74	27.5184	24.8976

CADMIUM CONCENTRATIONS IN FAT TISSUE, $\mu g/gm$ wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean-0.0288)		
*2137-74	0.0326	0.0370
*2327-74	0.0220	0.0299
2521-74	<0.0132	0.0158
*2576-74	0.0185	0.0229
183-75	0.0550	-
225-75	0.0194	<0.0132
368-75	0.0387	0.0405
671-75	<0.0132	<0.0132
* 688-75	0.0167	0.0202
* 886-75	<0.0132	<0.0132
*1138-75	0.0387	0.0255
*1224-75	0.0607	0.0264
1265-75	<0.0132	<0.0132
*1312-75	0.0273	0.0528
1317-75	0.0282	0.0414
*1402-75	0.0238	0.0801
*1505-75	0.0827	0.0431
Age Group 20-29 (Mean 0.0312)		
*1989-74	0.0686	0.0801
*2190-74	<0.0132	<0.0132
*2201-74	0.0282	0.0396
*2313-74	0.0590	0.0783
*2376-74	0.0220	0.0581
2563-74	<0.0132	<0.0132
*2577-74	0.0176	0.0194
*2590-74	<0.0132	<0.0132
* 104-75	0.0378	0.0167
* 117-75	0.0141	0.0185
* 218-75	0.0880	0.0651
* 279-75	0.0220	<0.0132
* 286-75	0.0484	0.0238
* 296-75	0.0378	0.0422
298-75	0.0141	<0.0132
* 324-75	0.0581	0.0493
* 335-75	<0.0132	0.0167
* 472-75	0.0211	0.0299
548-75	0.0220	0.0317
582-75	<0.0132	0.0176
* 786-75	0.0546	0.0528
*1272-75	0.0255	0.0326
Age Group 30-39 (Mean-0.0411)		
1706-74	0.0202	0.0387
1978-74	0.0317	0.4638
Age Group 30-39 (Mean-0.0411) (Cont'd)		
2059-74	0.0176	0.0158
*2112-74	0.0616	0.0598
*2121-74	0.0757	0.0590
2122-74	0.0202	0.0255
*2132-74	0.0854	0.0484
*2140-74	0.0695	0.0396
*2175-74	0.0290	0.0202
2184-74	<0.0132	<0.0132
2273-74	<0.0132	<0.0132
* 60-75	0.0810	0.0554
257-75	0.0299	0.0185
* 360-75	0.0334	0.0176
* 393-75	<0.0132	0.0554
* 425-75	<0.0132	0.0264
514-75	0.0132	0.0581
* 635-75	0.0246	0.0352
* 677-75	<0.0132	0.0246
* 733-75	0.0651	0.0185
* 740-75	0.0449	0.0273
* 753-75	0.0211	0.0264
* 794-75	0.0343	0.0370
* 899-75	0.0282	0.0449
Age Group 40-49 (Mean-0.0517)		
1647-74	0.0264	<0.0132
*1972-74	0.0370	0.0827
*2089-74	0.0704	0.0238
2129-74	0.0246	0.0220
*2131-74	0.0299	0.0220
*2143-74	0.0493	0.0211
*2301-74	0.0942	0.0950
*2367-74	0.0211	<0.0132
*2379-74	0.1056	0.0906
2598-74	0.0185	0.0290
* 184-75	0.0264	0.0220
* 219-75	0.0431	0.0414
* 336-75	0.1540	0.0827
* 439-75	0.0818	0.0704
*1335-75	0.1294	0.1258
*1417-75	0.0176	<0.0132
Age Group 50-59 (Mean-0.0444)		
*1694-74	0.0598	0.0766
*2024-74	<0.0132	<0.0132

CADMIUM CONCENTRATIONS IN FAT TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2	Autopsy No.	Concentration 1	Concentration 2
Age Group 50-59 (Mean–0.0444) (Cont'd)					
*2031-74	0.0528	0.0634			
*2042-74	0.0484	0.0414			
*2055-74	<0.0132	0.0158			
2156-74	0.0132	<0.0132			
*2170-74	0.0898	0.0510			
*2317-74	0.1082	0.1241			
*2334-74	0.0519	0.0431			
*2354-74	0.0783	0.0713			
2536-74	0.0414	0.0607			
*2578-74	0.0510	0.0370			
*2608-74	0.0282	0.0167			
1-75	<0.0132	<0.0132			
* 35-75	0.0273	0.0141			
* 62-75	0.0211	0.1206			
* 70-75	0.0458	0.0396			
* 71-75	0.0264	0.0537			
Age Group 60+ (Mean–0.3867)					
*2182-74	0.3652	0.4083			

APPENDIX G

AUTOPSY TISSUE
LEAD RAW DATA

LEAD CONCENTRATIONS IN MUSCLE TISSUE, μg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group, 10-19 (Mean--0.065)		
1674-74	0.0857	0.0490
1840-74	0.0870	0.0571
1924-74	0.0394	0.0408
*1990-74	0.1931	0.1578
*2137-74	0.0639	0.0408
*2223-74	0.0966	0.0626
*2327-74	0.1210	0.0898
2398-74	0.0707	0.0802
2408-74	0.0843	0.0354
2499-74	0.0598	0.0626
2521-74	<0.0231	0.0530
*2576-74	0.0544	0.0762
* 2-75	0.0490	0.0530
183-75	0.0993	0.1170
225-75	0.0694	0.0476
368-75	0.0422	0.0394
671-75	0.0435	0.0408
* 688-75	0.0381	0.0612
* 886-75	0.0612	0.0653
*1138-75	0.0925	0.0911
*1224-75	0.0653	0.0843
1265-75	0.0408	0.0775
*1312-75	0.0503	0.0680
1317-75	0.0367	0.0639
*1402-75	0.0612	0.0666
*1505-75	0.0707	0.0911
*1570-75	0.0258	0.0394
*1571-75	0.0462	0.0340
*1679-75	0.0544	0.0354
*1689-75	0.0354	0.0476
1876-75	0.1170	0.0490
1975-75	0.1156	0.0721
*1995-75	0.0476	0.0653
Age Group, 20-29 (Mean - 0.0768)		
1564-74	0.0435	0.0626
*1671-74	0.0707	0.1455
1716-74	0.1006	0.1020
*1785-74	0.0490	0.0408
1828-74	0.0422	0.0639
*1836-74	0.0435	0.0367
1861-74	0.0299	0.0394
*1888-74	<0.0231	<0.0231
*1903-74	0.0490	0.0326
1923-74	0.0558	0.0816
Age Group, 20-29 (Mean--0.0768) (Cont'd)		
*1936-74	0.0435	0.0816
*1989-74	0.0802	0.1074
*2190-74	0.0666	0.0666
*2201-74	0.2353	0.3441
*2261-74	0.0680	0.1632
*2313-74	0.0680	0.1006
*2376-74	0.0911	0.1428
2419-74	0.0938	0.1115
2431-74	0.1061	0.0680
2563-74	0.0707	0.0340
*2577-74	0.0993	0.1224
*2590-74	0.0666	0.0340
* 104-75	0.0666	0.1020
* 117-75	0.0734	0.1020
* 218-75	0.0789	0.0802
* 279-75	0.1822	0.0979
* 286-75	0.0408	0.0503
* 296-75	0.0530	0.0394
298-75	0.0748	0.0530
* 305-75	0.0585	0.0816
* 324-75	0.0408	0.0802
* 335-75	0.0462	0.0435
* 472-75	0.0993	0.0979
548-75	0.1102	0.0925
582-75	0.1170	0.0503
* 601-75	0.0530	0.0694
* 786-75	0.0408	0.0490
*1272-75	0.0517	0.0476
Age Group, 30-39 (Mean -0.0953)		
*1682-74	0.0476	0.0313
1706-74	0.0802	0.0680
*1830-74	0.0354	0.0231
*1900-74	0.0340	0.0326
1978-74	0.1034	0.1822
2059-74	0.0517	0.0802
*2112-74	0.1278	0.1578
*2121-74	0.0870	0.1346
2122-74	0.2434	0.1686
*2132-74	0.0802	0.0870
*2140-74	0.0286	0.0571
*2175-74	0.0680	0.0707
2184-74	0.0530	0.0544
*2220-74	0.0503	0.0816
*2238-74	0.0517	0.0490

*denotes cigarette smoker.

LEAD CONCENTRATIONS IN MUSCLE TISSUE, µg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	2
Age Group, 30-39 (Mean 0.0953) (Cont'd)		
2273-74	0.0762	0.0734
*2401-74	0.0680	0.0435
*2409-74	0.0449	0.0843
* 60-75	0.0721	0.0734
156-75	0.2149	0.2067
257-75	0.0721	0.0530
* 360-75	0.0762	0.0503
* 393-75	0.0490	0.0299
* 425-75	0.1020	0.1142
514-75	0.0462	0.0462
* 635-75	0.0530	0.0354
* 677-75	0.0381	0.0422
* 733-75	0.1102	0.0734
* 740-75	0.0653	0.0884
* 753-75	0.0490	0.0449
* 794-75	0.0734	0.0775
* 899-75	0.0680	0.0666
*1519-75	1.0050	0.8786
Age Group, 40-49 (Mean 0.0779)		
*1565-74	0.0476	0.0911
*1570-74	0.0966	0.1646
*1575-74	0.0381	0.0789
*1634-74	0.0775	0.0571
1647-74	0.1401	0.0925
1773-74	0.0354	0.0381
*1829-74	0.0354	0.0354
*1872-74	0.0503	0.0313
*1972-74	0.0612	0.0598
*2089-74	0.0462	0.0272
2129-74	0.0598	0.0707
*2131-74	<0.0231	0.0422
*2143-74	0.0666	0.0816
*2301-74	0.1319	0.0830
*2367-74	0.1795	0.2829
*2379-74	0.1020	0.0966
*2414-74	0.0571	0.0816
*2432-74	0.0422	0.0626
*2469-74	0.1142	0.0721
*2476-74	0.0354	0.0843
*2477-74	0.0585	0.0802
2598-74	0.0612	0.0558
* 184-75	0.1958	0.2720
* 219-75	0.0666	0.0666
* 336-75	0.0802	0.1292

Autopsy No.	Concentration 1	2
Age Group, 40-49 (Mean 0.0779) (Cont'd)		
* 439-75	0.0544	0.0843
*1335-75	0.0544	0.0571
*1417-75	0.0422	0.0326
Age Group, 50-59 (Mean 0.0964)		
*1562-74	0.0952	0.1333
*1694-74	0.1251	0.1360
1696-74	0.0966	0.0517
1742-74	.0.0340	0.0544
*1770-74	0.0245	0.0462
*1898-74	0.0802	0.0721
1920-74	0.0734	0.0666
*1945-74	0.1428	0.0571
*1953-74	0.0313	0.0612
*2024-74	0.0612	0.0639
*2031-74	0.3087	0.3346
*2042-74	0.0694	0.0422
*2055-74	0.0408	0.0367
2156-74	0.3210	0.4488
*2170-74	0.0476	0.0544
*2278-74	0.0462	0.0408
*2317-74	0.2693	0.2462
*2334-74	0.3223	0.3930
*2354-74	0.0653	0.0952
2427-74	0.0122	0.0408
*2443-74	0.0830	0.0884
2536-74	0.0598	0.0612
*2578-74	0.0748	0.0449
*2608-74	0.0639	0.0476
1-75	0.0381	0.0694
* 35-75	0.0898	0.0598
43-75	0.0503	0.0952
* 62-75	0.0449	0.0530
* 70-75	0.0544	0.0476
* 71-75	0.1387	0.0993
* 63-76	0.0476	0.0245
Age Group, 60+ (Mean -0.1140)		
*2182-74	0.1034	0.1251

LEAD CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight

Age Group, 10-19 (Mean-0.8313)

Autopsy No.	Concentration 1	Concentration 2
1674-74	0.6090	0.7395
1840-74	1.8183	1.7748
1924-74	0.4002	0.3132
*1990-74	1.0875	1.1745
*2137-74	0.6177	1.2006
*2223-74	0.6612	0.6699
*2327-74	2.5752	3.0885
2398-74	0.5916	0.6612
2408-74	0.5481	0.7134
2499-74	0.2088	0.2349
2521-74	0.8874	0.7308
*2576-74	0.5394	0.6090
* 2-75	0.9396	0.9831
183-75	0.6612	0.6786
225-75	0.2436	0.3915
368-75	0.3393	0.3741
671-75	0.2262	<0.2001
* 688-75	1.3572	1.5399
* 886-75	1.0440	1.0266
*1138-75	1.9314	1.2789
*1224-75	0.4698	0.4002
1265-75	0.5481	0.3654
*1312-75	0.9918	1.2006
1317-75	0.5829	0.3915
*1402-75	0.5307	0.5829
*1505-75	1.4790	1.4964
*1570-75	0.7395	1.0701
*1571-75	1.9314	1.3746
*1679-75	1.1484	1.2006
*1689-75	1.4529	1.7487
1876-75	0.5916	0.5655
1975-75	0.7134	0.6699
*1995-75	0.9657	0.7569

Age Group, 20-29 (Mean-0.9640)

Autopsy No.	Concentration 1	Concentration 2
1564-74	1.1136	1.0788
*1671-74	1.3572	1.2702
1716-74	0.6525	0.6525
*1785-74	1.4355	1.3746
1828-74	1.4181	1.4181
*1836-74	0.6177	0.6438
1861-74	0.9048	0.9048
*1888-74	0.7134	1.0440
*1903-74	0.3045	0.3393
1923-74	1.4094	1.4268

Age Group, 20-29 (Mean -0.9640) (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
*1936-74	1.7748	1.7574
*1989-74	1.9662	1.2615
*2190-74	0.6003	0.6090
*2201-74	3.8193	3.2625
*2261-74	0.7743	0.7656
*2313-74	1.2006	1.3572
*2376-74	0.9048	1.0962
2419-74	1.6791	1.7313
2431-74	0.9396	1.1745
2563-74	1.9749	1.9836
*2577-74	0.6351	0.9048
*2590-74	0.7308	0.6003
* 104-75	0.5046	0.4785
* 117-75	1.2876	1.3659
* 218-74	1.3833	1.6704
* 279-75	1.3137	1.3920
* 286-75	0.5655	0.5655
* 296-75	0.6264	0.6525
298-75	0.4089	0.4611
* 305-75	0.5742	0.5481
* 324-75	0.6525	0.9744
* 335-75	0.6264	0.7395
* 472-75	0.2697	<0.2001
548-75	1.5051	1.5399
582-75	0.8874	0.9570
* 601-75	0.2697	0.5133
* 786-75	0.4698	0.4263
*1272-75	0.7569	1.0179

Age Group, 30-39 (Mean-0.9937)

Autopsy No.	Concentration 1	Concentration 2
*1682-74	0.4350	0.3828
1706-74	2.8101	2.6709
*1830-74	1.0266	1.0701
*1900-74	0.8091	0.7482
1978-74	2.9145	3.0363
2059-74	1.5312	1.5486
*2112-74	0.4350	0.5133
*2121-74	0.8265	0.6612
2122-74	1.6095	1.2876
*2132-74	0.8700	0.8613
*2140-74	0.5829	0.6351
*2175-74	2.7318	3.0537
2184-74	1.0092	1.1136
*2220-74	1.4877	1.6878
*2238-74	1.6530	1.6095

LEAD CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group, 30-39 (Mean - 0.9937) (Cont'd)		
2273-74	0.6264	1.1136
*2401-74	0.8439	0.9222
*2409-74	0.9048	1.0266
* 60-75	1.1484	1.2528
156-75	0.4002	0.3828
257-75	1.0266	1.0527
* 360-75	0.8439	0.8526
* 393-75	<0.2001	<0.2001
* 425-75	<0.2001	0.2175
514-75	0.4176	0.4176
* 635-75	1.2528	1.2006
* 677-75	1.1571	1.1571
* 733-75	0.5742	0.8004
* 740-75	1.4355	1.2093
* 753-75	2.2098	2.0358
* 794-75	0.7830	0.8352
* 899-75	0.4002	0.6003
*1519-75	0.6264	0.8091
Age Group, 40-49 (Mean - 0.8094)		
*1565-74	0.9135	0.9048
*1570-74	1.3833	1.4094
*1575-74	0.4350	0.4959
*1634-74	1.4442	2.0184
1647-74	1.6791	1.6095
1733-74	1.7574	1.7139
*1829-74	0.9744	1.0266
*1872-74	1.0179	0.9831
*1972-74	0.3828	0.4089
*2089-74	0.2436	0.2262
2129-74	0.6786	0.5481
*2131-74	1.2093	1.1484
*2143-74	1.2789	1.2267
*2301-74	0.7569	0.7743
*2367-74	0.8265	0.6960
*2379-74	1.5399	1.5747
*2414-74	1.0092	1.0788
*2432-74	0.6177	0.7395
*2469-74	0.7221	0.4698
*2476-74	0.2088	0.2088
*2477-74	0.3654	0.2784
2598-74	0.9048	0.8874
* 184-75	0.7395	0.8265
* 219-75	0.2784	0.3654
* 336-75	0.3132	0.3654

Autopsy No.	Concentration 1	Concentration 2
Age Group, 40-49 (Mean - 0.8094) (Cont'd)		
* 439-75	0.6264	0.5046
*1335-75	0.8265	0.7569
*1417-75	0.9396	0.9483
Age Group, 50-59 (Mean - 0.6837)		
*1562-74	0.9048	0.8265
*1694-74	0.3654	0.3480
1696-74	0.9831	0.9309
1742-74	0.9309	0.8961
*1770-74	0.6177	0.6525
*1898-74	0.5916	0.6264
1920-74	0.7656	0.8178
*1945-74	0.3567	0.3393
*1953-74	0.4263	0.3654
*2024-74	0.4524	0.3828
*2031-74	0.5220	0.5220
*2042-74	0.9135	0.7743
*2055-74	0.6264	0.6351
2156-74	0.5916	0.7308
*2170-74	1.1397	1.0527
*2278-74	0.2871	0.3132
*2317-74	0.6525	0.6612
*2334-74	0.4698	0.5307
*2354-74	2.3142	2.2968
2427-74	1.1484	1.1136
*2443-74	0.7830	0.5394
2536-74	<0.2001	<0.2001
*2578-74	0.2784	0.3306
*2608-74	1.0179	1.0005
1-75	0.6438	0.5394
* 35-75	0.7395	0.8178
43-75	1.0440	1.2006
* 62-75	0.8265	0.5307
* 70-75	0.6351	0.6612
* 71-75	0.6873	0.4785
* 63-76	0.8526	0.9396
Age Group, 60+ (Mean - 0.7350)		
*2182-74	0.7047	0.7656

LEAD CONCENTRATIONS IN PANCREAS TISSUE, µg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group, 10-19 (Mean 0.4463)		
1674-74	0.3348	0.3294
1840-74	0.6210	0.6156
1924-74	0.2160	0.2484
*1990-74	0.6858	0.6059
*2137-74	0.4687	0.5378
*2223-74	0.3964	0.5033
*2327-74	1.0660	1.1740
2398-74	0.4752	0.5087
2408-74	0.2398	0.2668
2499-74	0.3488	0.4039
2521-74	0.5702	0.4795
*2576-74	0.2851	0.2452
* 2-75	0.4763	0.4331
183-75	0.6458	0.6134
225-75	0.3856	0.2819
368-75	0.2452	0.2322
671-75	0.3769	0.4201
* 688-75	0.7430	0.4979
* 886-75	0.8024	0.7517
*1138-75	0.7387	0.5044
*1224-75	0.3564	0.3197
1265-75	0.2441	0.2322
*1312-75	0.6815	0.5432
1317-75	0.2981	0.2484
*1402-75	0.3856	0.4201
*1505-75	0.5908	0.7139
*1570-75	0.3391	0.3607
*1571-75	0.4460	0.3294
*1679-75	0.5098	0.3715
*1689-75	0.3920	0.3456
1876-75	0.2830	0.2981
1975-75	0.2970	0.2754
*1995-75	0.5627	0.6469
Age Group, 20-29 (Mean 0.5144)		
1564-74	0.2635	0.2214
*1671-74	0.3391	0.3715
1716-74	0.1782	0.1782
*1785-74	0.2117	0.3240
1828-74	1.0044	1.0994
*1836-74	0.3316	0.2743
1861-74	0.3467	0.3996
*1888-74	0.4050	0.5184
*1903-74	0.1642	0.1966
1923-74	0.3305	0.4817

Autopsy No.	Concentration	
	1	2
Age Group, 20-29 (Mean 0.5144) (Cont'd)		
*1936-74	0.6134	0.7279
*1989-74	1.0066	0.8338
*2190-74	0.4072	0.4288
*2201-74	1.1610	1.1977
*2261-74	0.4342	0.4288
*2313-74	0.7949	0.7830
*2376-74	0.3542	0.3845
2419-74	0.8132	0.8014
2431-74	0.4406	0.4234
2563-74	0.5238	0.6512
*2577-74	0.3823	0.4374
*2590-74	0.2041	0.3629
* 104-75	0.6134	0.5486
* 117-75	0.7884	1.1210
* 218-75	0.7333	0.7538
* 279-75	1.1416	1.4116
* 286-75	0.3715	0.3132
* 296-75	0.3661	0.3942
298-75	0.2354	0.2614
* 305-75	0.6664	0.3942
* 324-75	1.0055	1.3576
* 335-75	0.3035	0.5152
* 472-75	0.6415	0.4903
548-75	0.6998	0.6350
582-75	0.4406	0.5108
* 601-75	0.3002	0.4201
* 786-75	0.3931	0.3294
*1272-75	0.2981	0.3672
Age Group, 30-39 (Mean - 0.4785)		
*1682-74	0.2084	0.3024
1706-74	0.6145	0.7376
*1830-74	0.2333	0.1685
*1900-74	0.4050	0.3791
1978-74	0.6340	0.5486
2059-74	0.4558	0.4007
*2112-74	0.3931	0.4450
*2121-74	0.3931	0.4687
2122-74	1.2452	1.2398
*2132-74	0.5551	0.6091
*2140-74	0.3251	0.3035
*2175-74	0.8100	0.7657
2184-74	0.4374	0.4104
*2220-74	0.5648	0.5648
*2238-74	0.6070	0.5065

LEAD CONCENTRATIONS IN PANCREAS TISSUE, µg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group, 30-39 (Mean 0.4785) (Cont'd)		
2273-74	0.4795	0.5011
*2401-74	0.5594	0.5357
*2409-74	0.4730	0.4396
* 60-75	0.4882	0.6059
156-75	0.1663	0.1868
257-75	0.4363	0.4568
* 360-75	0.4028	0.4093
* 393-75	0.2052	0.1987
* 425-75	0.4028	0.2765
514-75	0.3737	0.3996
* 635-75	0.4255	0.3445
* 677-75	0.5184	0.4730
* 733-75	0.5162	0.4007
* 740-75	0.6901	0.5627
* 753-75	0.4568	0.4936
* 794-75	0.2862	0.2657
* 899-75	0.2549	0.1685
*1519-75	1.6232	1.9094
Age Group, 40-49 (Mean 0.3979)		
*1565-74	0.6448	0.5908
*1570-74	0.2851	0.3834
*1575-74	<0.1436	0.1436
*1634-74	0.2257	0.2711
1647-74	0.4115	0.4568
1773-74	0.4644	0.7020
*1829-74	0.7387	0.6232
*1872-74	0.2776	0.2538
*1972-74	0.1620	0.2084
*2089-74	0.2506	0.4331
2129-74	0.5281	0.4687
*2131-74	0.3510	0.4957
*2143-74	0.3953	0.3899
*2301-74	0.4439	0.3521
*2367-74	0.2948	0.3510
*2379-74	0.7906	0.8024
*2414-74	0.6815	0.7150
*2432-74	0.2743	0.2624
*2469-74	0.3845	0.3337
*2476-74	0.4601	0.4158
*2477-74	0.2279	0.3704
2598-74	0.3251	0.3931
* 184-75	0.5551	0.5486
* 219-75	0.3229	0.2603
* 336-75	0.4536	0.4471
Age Group, 40-49 (Mean -0.3979) (Cont'd)		
* 439-75	0.4644	0.3089
*1335-75	0.3035	0.2614
*1417-75	0.3650	0.3596
Age Group, 50-59 (Mean - 0.3324)		
*1562-74	0.2581	0.2678
*1694-74	0.3499	0.4666
1696-74	0.3326	0.3769
1742-74	0.4050	0.3197
*1770-74	0.1555	0.2063
*1898-74	0.2063	0.2333
1920-74	0.3359	0.2711
*1945-74	<0.1436	0.1717
*1953-74	0.1955	<0.1436
*2024-74	0.2992	0.2678
*2031-74	<0.1436	<0.1436
*2042-74	0.4104	0.3575
*2055-74	0.1836	0.2279
2156-74	0.2149	0.2938
*2170-74	0.5432	0.5486
*2278-74	0.3618	0.4072
*2317-74	0.7679	0.8132
*2334-74	0.4568	0.4450
*2354-74	0.4223	0.3769
2427-74	0.4698	0.4190
*2443-74	0.5508	0.3640
2536-74	0.1652	<0.1436
*2578-74	0.3100	0.2603
*2608-74	0.5702	0.4039
1-75	0.2538	0.2948
* 35-75	0.5324	0.5800
43-75	0.4471	0.3715
* 62-75	0.3931	0.2322
* 70-75	0.2052	0.2376
* 71-75	0.5130	0.4730
* 63-76	0.3845	0.4234
Age Group, 60+ (Mean -0.5200)		
*2182-74	0.4784	0.5627

LEAD CONCENTRATIONS IN KIDNEY TISSUE, µg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group, 10-19 (Mean 0.4667)		
1674-74	0.4025	0.4715
1840-74	0.3220	0.3105
1924-74	0.3335	0.2760
*1990-74	1.4260	1.2995
*2137-74	0.3680	0.4485
*2223-74	0.2990	0.4255
*2327-74	1.1615	1.2535
2398-74	0.2530	0.4025
2408-74	0.2300	0.3220
2499-74	0.4830	0.4715
2521-74	0.3910	0.4830
*2576-74	0.2875	0.3105
* 2-75	0.3450	0.2645
183-75	0.2760	0.1725
225-75	<0.1035	<0.1035
368-75	0.1380	0.1495
671-75	0.1840	0.1840
* 688-75	0.6900	0.5520
* 886-75	0.6095	0.6210
*1138-75	0.9200	1.0810
*1224-75	0.3450	0.4140
1265-75	0.5980	0.4600
*1312-75	0.4485	0.5060
1317-75	0.4370	0.4255
*1402-75	0.3795	0.5175
*1505-75	1.3570	1.2190
*1570-75	0.2760	0.2990
*1571-75	0.4025	0.3910
*1679-75	0.7360	0.8050
*1689-75	0.4485	0.4600
1876-75	0.2760	0.2645
1975-75	0.3335	0.3105
*1995-75	1.1270	0.8510
Age Group, 20-29 (Mean 0.5699)		
1564-74	0.2875	0.4025
*1671-74	0.9545	0.9085
1716-74	0.5060	0.5865
*1785-74	0.6095	0.5750
1828-74	1.1845	1.1040
*1836-74	0.5865	0.4370
1861-74	0.6440	0.4945
*1888-74	0.5750	0.5980
*1903-74	0.3680	0.3220
1923-74	0.3910	0.4025

Autopsy No.	Concentration	
	1	2
Age Group, 20-29 (Mean- 0.5699) (Cont'd)		
*1936-74	0.9430	1.0350
*1989-74	1.0465	1.1500
*2190-74	0.5175	0.6210
*2201-74	1.6100	1.5065
*2261-74	0.4600	0.4715
*2313-74	0.6785	0.8280
*2376-74	0.2530	0.3450
2419-74	0.4830	0.4945
2431-74	0.8050	0.8050
2563-74	0.7820	0.8395
*2577-74	0.5290	0.4370
*2590-74	0.3565	0.4255
* 104-75	0.2990	0.3105
* 117-75	0.8740	0.6670
* 218-75	0.8050	1.0925
* 279-75	1.0465	1.3455
* 286-75	0.4485	0.4715
* 296-75	0.3795	0.3910
298-75	0.3105	0.2760
* 305-75	0.2415	0.2415
* 324-75	0.4370	0.4370
* 335-75	0.6095	0.4370
* 472-75	0.6785	0.6095
548-75	0.6785	0.8050
582-75	0.5980	0.5635
* 601-75	0.2300	0.2300
* 786-75	0.2415	0.1955
*1272-75	0.4715	0.5520
Age Group, 30-39 (Mean -0.5621)		
*1682-74	0.4485	0.3910
1706-74	1.2765	1.4950
*1830-74	0.2760	0.4485
*1900-74	0.2760	0.3795
1978-74	0.7935	0.8280
2059-74	0.6095	0.7245
*2112-74	0.2875	0.3450
*2121-74	0.7015	0.7015
2122-74	1.7020	1.5985
*2132-74	0.6670	0.5520
*2140-74	0.2990	0.3105
*2175-74	0.9085	1.2420
2184-74	0.5520	0.5060
*2220-74	0.5060	0.5635
*2238-74	1.0120	0.8395

LEAD CONCENTRATIONS IN KIDNEY TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration	
	1	2
Age Group, 30-39 (Mean 0.5621) (Cont'd)		
2273-74	0.6555	0.6555
*2401-74	0.7590	0.6555
*2409-74	0.4025	0.4600
* 60-75	0.8050	0.8050
156-75	0.1840	0.2875
257-75	0.9085	0.8280
* 360-75	0.4830	0.5520
* 393-75	0.2070	0.3450
* 425-75	0.2415	0.2070
514-75	0.5060	0.2760
* 635-75	0.2990	0.2875
* 677-75	0.3220	0.4255
* 733-75	0.5290	0.5750
* 740-75	0.6670	0.8050
* 753-75	0.7475	0.6670
* 794-75	0.4715	0.4025
* 899-75	0.3105	0.4715
*1519-75	0.2530	0.2990
Age Group, 40-49 (Mean 0.4933)		
*1565-74	1.0120	0.6670
*1570-74	0.5290	0.5175
*1575-74	0.5750	0.5635
*1634-74	0.7245	0.7590
1647-74	0.4025	0.4485
1773-74	1.1270	1.1040
*1829-74	0.6095	0.6095
*1872-74	0.1840	0.2530
*1972-74	0.4255	0.4370
*2089-74	0.2760	0.3335
2129-74	0.2760	0.3450
*2131-74	0.2070	0.2760
*2143-74	0.7130	0.7245
*2301-74	0.2990	0.2760
*2367-74	0.4140	0.4945
*2379-74	1.2420	1.3225
*2414-74	0.4600	0.4945
*2432-74	0.4370	0.4370
*2469-74	0.4830	0.5060
*2476-74	0.2070	0.2300
*2477-74	0.1610	0.1150
2598-74	0.9200	0.6095
* 184-75	0.5405	0.8165
* 219-75	0.1725	0.1380
* 336-75	0.3680	0.3795
Age Group, 40-49 (Mean–0.4933) (Cont'd)		
* 439-75	0.2300	0.4025
*1335-75	0.7130	0.8855
*1417-75	0.5865	0.4715
Age Group, 50-59 (Mean 0.5038)		
*1562-74	0.6440	0.4830
*1694-74	0.3565	0.3910
1696-74	0.6440	0.8625
1742-74	0.2875	0.2760
*1770-74	0.1380	0.1955
*1898-74	0.2300	0.4140
1920-74	0.2530	0.3910
*1945-74	0.1955	0.1955
*1953-74	0.4140	0.3910
*2024-74	1.0695	1.1845
*2031-74	0.2530	0.1725
*2042-74	1.0005	0.4485
*2055-74	0.4370	0.4715
2156-74	1.1040	0.9545
*2170-74	0.6785	0.7935
*2278-74	0.2070	0.3105
*2317-74	1.4720	1.4720
*2334-74	0.7820	0.9660
*2354-74	0.3795	0.4025
2427-74	0.1725	0.1035
*2443-74	0.4140	0.4370
2536-74	0.5405	0.5865
*2578-74	0.3565	0.3335
*2608-74	0.5520	0.4945
1.75	0.9545	0.8050
* 35-75	0.6325	0.6325
43-75	0.7360	0.6785
* 62-75	0.2415	0.2530
* 70-75	0.2185	0.2415
* 71-75	0.4370	0.4140
* 63-76	0.7360	0.7360
Age Group, 60+ (Mean–0.4933)		
* 2182-74	0.5405	0.4485

LEAD CONCENTRATIONS IN FAT TISSUE, μg/gm wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean -0.2486)		
*2137-74	<0.0449	0.5386
*2327-74	2.1701	0.7220
2521-74	0.1069	<0.0449
*2576-74	<0.0449	<0.0449
183-75	0.4224	--
225-75	0.0832	<0.0449
368-75	0.1954	0.1280
671-75	<0.0449	0.0449
* 688-75	0.0739	0.1597
* 886-75	<0.0449	0.0449
*1138-75	1.0349	0.7260
*1224-75	<0.0449	0.1043
1265-75	0.7088	0.6834
*1312-75	<0.0449	0.2666
1317-75	0.1096	0.4699
*1402-75	0.2878	0.3643
*1505-75	0.1426	0.0713
Age Group 20-29 (Mean -0.2373)		
*1989-74	0.0568	0.0990
*2190-74	<0.0449	<0.0449
*2201-74	0.1135	0.6877
*2313-74	0.7867	0.7352
*2376-74	1.4916	2.5093
2563-74	0.1650	0.0475
*2577-74	0.2930	0.2561
*2590-74	<0.0449	0.0607
* 104-75	0.4158	0.3498
* 117-75	0.1280	0.0911
* 218-75	0.0713	<0.0449
* 279-75	<0.0449	<0.0449
* 286-75	<0.0449	<0.0449
* 296-75	0.2191	0.4633
298-75	0.1214	0.1544
* 324-75	0.4844	0.2534
* 335-75	0.0911	0.0752
* 472-75	0.1280	<0.0449
548-75	0.4158	0.2152
582-75	<0.0449	0.0766
* 786-75	0.5570	0.1742
*1272-75	0.2561	0.2336
Age Group 30-39 (Mean 0.3146)		
1706-74	0.3590	0.0607
1978-74	0.1861	<0.0449
Age Group 30-39 (Mean–0.3146) (Cont'd)		
2059-74	0.1452	0.0449
*2112-74	0.1188	0.1861
*2121-74	0.2270	0.4765
2122-74	0.6046	0.2653
*2132-74	0.5359	0.5623
*2140-74	0.7616	1.1418
*2175-74	0.5438	0.3828
2184-74	0.0713	<0.0449
2273-74	0.5887	0.4211
* 60-75	0.2323	<0.0449
257-75	<0.0449	<0.0449
* 360-75	0.3181	0.2297
* 393-75	0.9768	0.8039
* 425-75	0.0700	0.5333
514-75	<0.0449	<0.0449
* 635-75	0.0950	0.1742
* 677-75	0.4805	0.4726
* 733-75	1.7543	0.3300
* 740-75	0.3155	<0.0449
* 753-75	0.4435	0.1742
* 794-75	0.3907	0.4567
* 899-75	0.0884	0.1333
Age Group 40-49 (Mean -0.2645)		
1647-74	<0.0449	<0.0449
*1972-74	1.0415	0.9438
*2089-74	0.3617	<0.0449
2129-74	0.2442	<0.0449
*2131-74	0.3564	0.2125
*2143-74	<0.0449	0.0990
*2301-74	<0.0449	<0.0449
*2367-74	<0.0449	<0.0449
*2379-74	0.3274	0.9913
2598-74	1.0283	0.4475
* 184-75	0.1386	0.2257
* 219-75	0.2851	0.2838
* 336-75	0.1320	<0.0449
* 439-75	0.0964	0.9570
*1335-75	0.3023	0.4462
*1417-75	0.2640	0.1650
Age Group 50-59 (Mean -0.2005)		
*1694-74	0.1544	0.0858
*2024-74	0.3630	0.2996

LEAD CONCENTRATIONS IN FAT TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration		Autopsy No.	Concentration	
	1	2		1	2
Age Group 50-59 (Mean 0.2005) (Cont'd)					
*2031-74	0.0964	<0.0449			
*2042-74	0.0554	0.0700			
*2055-74	0.2244	0.7300			
2156-74	0.0607	0.1122			
*2170-74	0.4250	0.0554			
*2317-74	0.1756	0.1030			
*2334-74	0.0660	<0.0449			
*2354-74	0.1280	0.1940			
2536-74	0.1003	0.2125			
*2578-74	0.5795	0.6389			
*2608-74	1.2144	0.0911			
1-75	<0.0449	<0.0449			
* 35-75	<0.0449	0.0581			
* 62-75	0.5597	0.1043			
* 70-75	0.5161	<0.0449			
* 71-75	0.2336	0.1478			
Age Group 60+ (Mean 0.5233)					
*2182-74	0.7498	0.3260			

APPENDIX H

AUTOPSY TISSUE ZINC RAW DATA

ZINC CONCENTRATIONS IN MUSCLE TISSUE, μg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group 10-19 (Mean–95.01)		
1674-74	114.8	111.2
1840-74	103.8	103.8
1924-74	82.7	65.1
*1990-74	124.9	107.1
*2137-74	133.8	96.4
*2223-74	73.4	77.8
*2327-74	104.9	79.6
2398-74	71.1	71.1
2408-74	64.0	46.2
2499-74	98.3	74.4
2521-74	40.2	47.6
*2576-74	50.8	54.8
* 2-75	122.9	122.9
183-75	107.6	122.4
225-75	153.3	116.7
368-75	99.7	86.8
671-75	96.6	105.7
* 688-75	108.5	88.6
* 886-75	104.0	100.4
*1138-75	94.6	170.8
*1224-75	112.7	87.3
1265-75	109.0	143.6
*1312-75	96.6	85.7
1317-75	85.8	116.7
*1402-75	94.0	94.0
*1505-75	74.2	101.3
*1570-75	79.6	86.8
*1571-75	136.4	98.2
*1679-75	106.6	89.7
*1689-75	89.0	125.4
1876-75	103.7	83.7
1975-75	110.9	163.6
*1995-75	127.3	114.7
Age Group 20-29 (Mean 98.89)		
1564-74	133.3	169.8
*1671-74	132.9	114.2
1716-74	112.4	104.5
*1785-74	94.7	98.8
1828-74	116.7	89.3
*1836-74	95.7	87.5
1861-74	88.1	82.7
*1888-74	100.4	112.6
*1903-74	65.8	56.2
1923-74	103.1	94.8
Age Group 20-29 (Mean–98.89) (Cont'd)		
*1936-74	112.4	97.7
*1989-74	99.8	101.9
*2190-74	105.5	80.1
*2201-74	89.9	106.9
*2261-74	66.8	90.0
*2313-74	71.3	107.1
*2376-74	87.3	150.8
2419-74	100.4	160.1
2431-74	73.4	73.4
2563-74	51.0	72.8
*2577-74	70.3	70.3
*2590-74	58.6	55.0
* 104-75	103.7	121.9
* 117-75	132.7	140.0
* 218-75	102.0	105.8
* 279-75	121.4	93.4
* 286-75	95.3	99.1
* 296-75	109.4	113.1
298-75	132.5	106.9
* 305-75	128.9	106.6
* 324-75	83.2	74.8
* 335-75	89.0	104.0
* 472-75	114.8	107.5
548-75	111.1	118.4
582-75	109.4	98.4
* 601-75	114.9	94.9
* 786-75	132.7	143.6
*1272-75	100.4	111.3
Age Group 30-39 (Mean–96.26)		
*1682-74	147.6	151.3
1706-74	101.3	119.3
*1830-74	103.8	91.6
*1900-74	102.4	66.4
1978-74	140.7	129.5
2059-74	100.1	78.3
*2112-74	113.8	170.5
*2121-74	97.1	88.9
2122-74	102.6	95.3
*2132-74	125.5	120.0
*2140-74	55.3	85.7
*2175-74	92.8	91.1
2184-74	150.9	128.6
*2220-74	65.9	76.9
*2238-74	58.1	76.0

*denotes cigarette smoker.

ZINC CONCENTRATIONS IN MUSCLE TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration	
	1	2
Age Group 30-39 (Mean 96.26) (Cont'd)		
2273-74	86.8	77.8
*2401-74	41.0	44.0
*2409-74	92.2	83.3
* 60-75	85.9	85.9
156-75	89.0	89.0
257-75	93.4	123.3
* 360-75	68.4	67.1
* 393-75	106.4	110.3
* 425-75	121.1	122.9
514-75	81.4	85.0
* 635-75	95.3	106.6
* 677.75	92.9	89.3
* 733-75	107.3	129.3
* 740-75	96.5	138.3
* 753-75	103.7	116.5
* 794-75	89.7	82.2
* 899-75	94.6	120.0
*1519-75	87.2	154.5
Age Group 40-49 (Mean - 90.83)		
*1565-74	97.1	110.8
*1570-74	90.8	109.9
*1575-74	130.2	96.2
*1634-74	109.9	94.2
1647-74	149.4	118.4
1773-74	109.9	115.2
*1829-74	89.1	80.8
*1872-74	87.7	109.9
*1972-74	95.2	119.1
*2089-74	92.2	118.2
2129-74	78.8	71.6
*2131-74	87.5	98.2
*2143-74	63.7	76.5
*2301-74	79.5	71.5
*2367-74	92.8	78.6
*2379-74	52.1	56.9
*2414-74	44.0	58.7
*2432-74	73.3	132.9
*2469-74	109.1	176.2
*2476-74	80.4	80.4
*2477-74	72.5	72.5
2598-74	43.3	36.1
* 184-75	117.1	121.1
* 219-75	76.1	96.5
* 336-75	89.3	113.0
* 439-75	110.8	96.0

Autopsy No.	Concentration	
	1	2
Age Group 40-49 (Mean- 90.83) (Cont'd)		
*1335-75	122.2	120.2
*1417-75	129.5	107.6
Age Group 50-59 (Mean–90.29)		
*1562-74	77.3	69.1
*1694-74	136.5	117.0
1696-74	131.2	100.2
1742-74	110.6	106.4
*1770-74	141.9	114.7
*1898-74	73.8	117.5
1920-74	79.7	108.5
*1945-74	130.2	155.1
*1953-74	119.5	98.9
*2024-74	117.6	156.1
*2031-74	82.4	109.3
*2042-74	87.5	92.9
*2055-74	74.6	80.1
2156-74	109.8	102.0
*2170-74	69.5	63.6
*2278-74	69.7	76.8
*2317-74	101.8	101.7
*2334-74	81.3	95.7
*2354-74	68.8	68.8
2427-74	102.7	85.1
*2443-74	152.5	93.9
2536-74	35.0	37.4
*2578-74	84.8	97.3
*2608-74	54.3	32.5
1-75	96.5	109.1
* 35-75	104.9	112.1
43-75	121.4	102.7
* 62-75	82.0	100.2
* 70-75	100.1	120.1
* 71-75	54.3	52.4
* 63-76	71.6	75.6
Age Group 60+ (Mean - 79.20)		
*2182-74	66.8	93.9

ZINC CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean 54.44)		
1674-74	57.0	54.7
1840-74	81.2	82.2
1924-74	60.6	56.4
*1990-74	72.8	69.1
*2137-74	63.5	59.6
*2223-74	77.4	74.4
*2327-74	87.3	68.2
2398-74	59.5	58.1
2408-74	78.8	55.4
2499-74	40.8	42.4
2521-74	44.4	52.2
*2576-74	45.4	44.2
* 2-75	40.1	43.4
183-75	86.7	65.6
225-75	50.5	86.9
368-75	47.0	52.9
671-75	27.7	46.6
* 688-75	84.4	85.5
* 886-75	43.3	43.3
*1138-75	44.5	69.8
*1224-75	37.2	26.3
1265-75	48.2	50.4
*1312-75	37.3	69.2
1317-75	62.0	43.0
*1402-75	45.7	34.3
*1505-75	81.3	98.7
*1570-75	45.2	36.8
*1571-75	59.5	40.5
*1679-75	64.5	56.7
*1689-75	59.1	63.5
1876-75	38.3	52.5
1975-75	58.3	46.4
*1995-75	47.1	38.5
Age Group 20-29 (Mean- 59.21)		
1564-74	79.9	78.3
*1671-74	88.0	78.5
1716-74	112.5	125.4
*1785-74	75.6	87.9
1828-74	78.8	76.8
*1836-74	47.2	45.6
1861-74	80.7	80.8
*1888-74	67.1	38.6
*1903-74	36.2	34.6
1923-74	81.4	81.9
*1936-74	52.0	51.0
Age Group 20-29 (Mean–59.21) (Cont'd)		
*1989-74	51.3	38.8
*2190-74	91.2	59.6
*2201-74	56.1	57.1
*2261-74	61.7	59.5
*2313-74	60.6	65.0
*2376-74	48.7	50.1
2419-74	59.4	58.3
2431-74	52.9	54.6
2563-74	55.4	53.7
*2577-74	45.7	45.7
*2590-74	50.1	89.4
* 104-75	48.3	66.2
* 117-75	54.5	56.6
* 218-75	56.7	51.2
* 279-75	54.9	61.5
* 286-75	80.0	66.8
* 296-75	53.8	56.0
298-75	62.4	62.4
* 305-75	71.8	69.6
* 324-75	40.6	39.4
* 335-75	34.9	45.7
* 472-75	47.7	47.7
548-75	88.9	64.8
582-75	67.8	57.0
* 601-75	21.2	37.8
* 786-75	122.2	91.3
*1272-75	49.1	43.5
Age Group 30-39 (Mean -58.32)		
*1682-74	35.6	32.7
1706-74	97.7	76.3
*1830-74	72.1	71.7
*1900-74	77.5	64.5
1978-74	73.4	66.7
2059-74	43.8	65.8
*2112-74	56.4	91.2
*2121-74	25.7	20.6
2122-74	55.1	54.1
*2132-74	60.4	64.1
*2140-74	41.6	43.4
*2175-74	80.6	75.4
2184-74	88.1	76.0
*2220-74	55.6	59.5
*2238-74	71.1	71.9
2273-74	80.2	71.4
*2401-74	51.4	52.4

ZINC CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration	
	1	2
Age Group 30-39 (Mean -58.32) (Cont'd)		
*2409-74	83.9	65.9
* 60-75	58.0	49.3
156-75	65.0	61.8
257-75	88.2	77.9
* 360-75	73.7	71.3
* 393-75	45.6	64.0
* 425-75	60.5	51.4
514-75	45.2	46.2
* 635-75	44.7	48.2
* 677-75	65.7	59.1
* 733-75	64.5	58.9
* 740-75	43.0	46.6
* 753-75	76.6	77.8
* 794-75	55.3	51.0
* 899-75	73.7	57.4
*1519-75	29.9	31.1
Age Group 40-49 (Mean 52.56)		
*1565-74	42.1	41.6
*1570-74	47.1	49.9
*1575-74	52.6	75.0
*1634-74	72.1	98.4
1647-74	82.4	73.5
1773-74	70.9	70.2
*1829-74	21.6	46.4
*1872-74	45.3	44.9
*1972-74	47.7	35.3
*2089-74	59.9	33.1
2129-74	86.8	152.5
*2131-74	63.4	64.2
*2143-74	40.6	37.7
*2301-74	65.7	64.1
*2367-74	52.0	51.2
*2379-74	45.8	38.7
*2414-74	54.4	56.4
*2432-74	48.9	57.9
*2469-74	79.2	58.5
*2476-74	80.9	73.9
*2477-74	27.4	28.5
2598-74	60.5	67.3
* 184-75	39.0	27.0
* 219-75	42.3	38.8
* 336-75	61.8	61.8
* 439-75	53.6	56.9
*1335-75	59.2	46.9
*1417-75	37.6	35.3

Autopsy No.	Concentration	
	1	2
Age Group 50-59 (Mean 49.40)		
*1562-74	43.0	40.6
*1694-74	41.1	25.7
1696-74	81.6	75.0
1742-74	52.1	42.5
*1770-74	42.4	44.4
*1898-74	36.0	33.7
1920-74	48.3	49.3
*1945-74	31.7	31.4
*1953-74	60.2	57.1
*2024-74	24.6	20.5
*2031-74	55.9	69.6
*2042-74	80.8	77.1
*2055-74	74.6	60.1
2156-74	45.5	53.0
*2170-74	45.8	46.9
*2278-74	46.7	46.9
*2317-74	43.4	56.3
*2334-74	57.8	56.2
*2354-74	35.0	29.1
2427-74	51.2	52.1
*2443-74	82.6	83.1
2536-74	38.2	35.8
*2578-74	61.4	45.3
*2608-74	47.5	40.4
1-75	43.3	44.2
* 35-75	38.5	38.5
43-75	74.6	52.9
* 62-75	30.8	27.9
* 70-75	111.2	94.6
* 71-75	62.5	63.5
* 63-76	87.0	87.0
Age Group 60+ (Mean -85.03)		
*2182-74	84.2	85.9

ZINC CONCENTRATIONS IN PANCREAS TISSUE, μg/gm wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean -28.96)		
1674-74	25.5	26.1
1840-74	29.5	35.0
1924-74	32.0	32.0
*1990-74	25.2	25.8
*2137-74	30.9	42.6
*2223-74	37.5	45.2
*2327-74	32.1	28.3
2398-74	23.4	30.0
2408-74	30.7	29.0
2499-74	24.4	26.7
2521-74	23.3	23.9
*2576-74	26.0	28.2
* 2-75	24.0	25.8
183-75	49.5	26.8
225-75	26.5	29.5
368-75	33.1	24.9
671-75	37.7	37.7
* 688-75	28.3	26.2
* 886-75	27.2	28.2
*1138-75	29.5	29.1
*1124-75	27.2	29.4
1265-75	34.6	28.1
*1312-75	33.3	29.0
1317-75	40.4	40.9
*1402-75	24.4	26.7
*1505-75	23.5	26.2
*1570-75	24.5	25.1
*1571-75	21.3	28.0
*1679-75	38.0	28.2
*1689-75	29.3	25.3
1876-75	27.0	29.5
1975-75	26.2	23.8
*1995-75	28.8	26.1
Age Group 20-29 (Mean - 25.48)		
1564-74	26.0	24.3
*1671-74	20.9	26.4
1716-74	14.6	16.5
*1785-74	23.7	21.2
1828-74	22.5	22.5
*1836-74	21.6	22.7
1861-74	28.3	25.9
*1888-74	33.9	29.0
*1903-74	28.5	47.9
1923-74	20.7	28.5

Autopsy No	Concentration 1	Concentration 2
Age Group 20-29 (Mean 25.48) (Cont'd)		
*1936-74	23.4	22.2
*1989-74	22.4	23.1
*2190-74	19.4	18.8
*2201-74	27.9	27.4
*2261-74	26.1	26.6
*2313-74	23.2	22.6
*2376-74	25.9	30.0
2419-74	24.8	30.5
2431-74	30.9	33.2
2563-74	18.1	19.3
*2577-74	21.5	18.6
*2590-74	22.2	22.7
* 104-75	28.7	23.2
* 117-75	41.9	41.9
* 218-75	28.8	28.8
* 279-75	29.4	31.0
* 286-75	37.1	32.8
* 296-75	24.8	25.4
298-75	24.5	24.5
* 305-75	33.7	28.2
* 324-75	31.7	24.4
* 335-75	26.1	29.2
* 472-75	31.4	23.6
548-75	27.0	25.6
582-75	31.5	31.5
* 601-75	19.0	22.3
* 786-75	24.9	22.7
*1272-75	16.2	22.9
Age Group 30-39 (Mean–24.88)		
*1682-74	17.7	25.5
1706-74	22.9	21.0
*1830-74	25.5	26.7
*1900-74	19.4	18.8
1978-74	23.3	14.1
2059-74	34.0	34.0
*2112-74	14.0	17.3
*2121-74	23.5	25.7
2122-74	34.8	30.4
*2132-74	28.7	21.5
*2140-74	25.1	22.3
*2175-74	32.9	29.0
2184-74	23.8	18.2
*2220-74	26.0	24.3
*2238-74	22.2	23.9

ZINC CONCENTRATIONS IN PANCREAS TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration	
	1	2
Age Group 30-39 (Mean 24.88) (Cont'd)		
2273-74	31.2	31.8
*2401-74	25.1	22.3
*2409-74	20.7	20.1
* 60-75	24.9	27.5
156-75	28.2	28.2
257-75	25.4	22.4
* 360-75	28.7	28.2
* 393-75	34.9	36.0
* 425-75	24.0	27.8
514-75	22.7	27.4
* 635-75	27.4	24.9
* 677-75	27.5	22.6
* 733-75	33.9	19.3
* 740-75	22.9	19.3
* 753-74	27.8	23.5
* 794-75	20.1	36.6
* 899-75	25.3	21.0
*1519-75	31.0	30.6
Age Group 40-49 (Mean 23.83)		
*1565-74	20.9	19.0
*1570-74	27.3	23.4
*1575-74	13.3	13.3
*1634-74	20.6	22.8
1647-74	26.1	28.9
1773-74	21.8	23.1
*1829-74	38.9	37.1
*1872-74	24.3	30.4
*1972-74	24.3	23.2
*2089-74	21.1	38.7
2129-74	22.1	22.9
*2131-74	23.2	21.6
*2143-74	36.6	20.1
*2301-74	21.0	20.6
*2367-74	17.5	18.5
*2379-74	19.4	18.9
*2414-74	31.7	28.9
*2432-74	22.8	26.1
*2469-74	21.6	29.4
*2476-74	53.9	46.8
*2477-74	14.5	17.3
2598-74	32.5	35.5
* 184-75	20.7	20.7
* 219-75	21.1	22.8
* 336-75	34.3	33.8
Age Group 40-49 (Mean -23.83) (Cont'd)		
* 439-75	31.4	22.1
*1335-75	13.7	15.6
*1417-75	19.4	20.0
Age Group 50-59 (Mean -21.63)		
*1562-74	20.1	18.9
*1694-74	11.7	13.4
1696-74	15.7	15.7
1742-74	26.7	24.3
*1770-74	20.0	22.1
*1898-74	17.8	19.0
1920-74	16.5	18.9
*1945-74	17.6	23.6
*1953-74	27.7	25.4
*2024-74	16.2	18.6
*2031-74	24.4	22.7
*2042-74	48.6	28.2
*2055-74	17.7	17.7
2156-74	9.4	16.6
*2170-74	24.5	25.6
*2278-74	22.2	23.3
*2317-74	22.7	21.0
*2334-74	18.8	23.5
*2354-74	20.6	20.6
2427-74	17.5	15.0
*2443-74	19.4	25.5
2536-74	42.7	28.2
*2578-74	14.6	21.0
*2608-74	24.8	26.0
1-75	12.8	14.0
* 35-75	24.4	20.0
43-75	33.9	23.9
* 62-75	23.9	26.2
* 70-75	20.2	15.5
* 71-75	33.3	30.9
* 63-76	49.7	65.2
Age Group 60+ (Mean -32.40)		
*2182-74	31.5	33.3

ZINC CONCENTRATIONS IN KIDNEY TISSUE, μg/gm wet weight

Age Group 10-19 (Mean 38.05)

Autopsy No.	Concentration	
	1	2
1674-74	26.0	31.7
1840-74	49.1	49.9
1924-74	49.6	49.6
*1990-74	50.8	50.8
*2137-74	34.6	51.5
*2223-74	45.0	52.2
*2327-74	40.5	43.9
2398-74	41.3	38.6
2408-74	38.8	40.7
2499-74	41.6	39.9
2521-74	23.2	35.3
*2576-74	39.6	42.4
* 2-75	55.4	49.6
183-75	14.7	20.7
225-75	20.8	26.7
368-75	31.5	37.5
671-75	28.2	29.2
* 688-75	40.5	31.9
* 886-75	35.0	36.7
*1138-75	61.6	58.3
*1224-75	49.6	47.8
1265-75	38.3	39.1
*1312-75	42.1	38.2
1317-75	40.0	40.8
*1402-75	34.2	33.5
*1505-75	43.0	40.4
*1570-75	27.3	29.0
*1571-75	24.5	32.5
*1679-75	48.6	48.6
*1689-75	34.0	32.7
1876-75	31.9	26.0
1975-75	60.0	75.3
*1995-75	35.7	34.4

Age Group 20-29 (Mean 41.89)

Autopsy No.	Concentration	
	1	2
1564-74	51.2	44.3
*1671-74	44.0	43.5
1716-74	40.5	43.9
*1785-74	59.8	55.1
1828-74	48.9	51.4
*1836-74	48.9	48.0
1861-74	47.4	47.8
*1888-74	48.3	44.2
*1903-74	49.6	44.5
1923-74	48.6	45.9
*1936-74	47.0	47.0

Age Group 20-29 (Mean- 41.89) (Cont'd)

Autopsy No.	Concentration	
	1	2
*1989-74	32.0	38.6
*2190-74	38.3	37.5
*2201-74	33.1	32.4
*2261-74	66.9	61.2
*2313-74	37.1	32.9
*2376-74	38.0	27.8
2419-74	58.3	57.0
2431-74	50.7	63.0
2563-74	29.4	32.8
*2577-74	54.6	101.0
*2590-74	55.4	47.0
* 104-75	35.3	33.2
* 117-75	33.2	41.3
* 218-75	56.8	45.2
* 279-75	47.4	47.4
* 286-75	36.3	37.0
* 296-75	32.5	33.9
298-75	47.4	30.2
* 305-75	23.7	27.3
* 324-75	48.8	58.9
* 335-75	38.0	60.3
* 472-75	63.6	43.5
548-75	38.0	40.8
582-75	40.8	48.6
* 601-75	51.5	45.8
* 786-75	35.7	40.5
*1272-75	56.7	56.2

Age Group 30-39 (Mean 47.09)

Autopsy No.	Concentration	
	1	2
*1682-74	41.1	38.5
1706-74	27.9	25.9
*1830-74	68.1	68.7
*1900-74	35.4	38.0
1978-74	28.5	34.4
2059-74	43.0	46.3
*2112-74	32.9	37.1
*2121-74	59.7	53.0
2122-74	44.7	42.2
*2132-74	43.9	50.5
*2140-74	39.7	42.2
*2175-74	67.5	52.3
2184-74	31.5	36.1
*2220-74	60.0	39.7
*2238-74	64.7	66.2
2273-74	55.0	46.6
*2401-74	72.1	73.4

ZINC CONCENTRATIONS IN KIDNEY TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group 30-39 (Mean - 47.09) (Cont'd)		
*2409-74	52.2	63.8
* 60-75	57.0	68.2
156-75	35.0	34.4
257-75	43.8	43.1
* 360-75	50.4	41.3
* 393-75	55.0	58.1
* 425-75	40.8	38.0
514-75	47.8	51.2
* 635-75	59.3	54.5
* 677-75	49.6	43.8
* 733-75	70.3	68.4
* 740-75	39.4	49.1
* 753-75	44.9	40.1
* 794-75	42.2	46.7
* 899-75	43.5	46.7
*1519-75	53.4	64.5
Age Group 40-49 (Mean 50.50)		
*1565-74	56.0	56.9
*1570-74	48.0	66.4
*1575-74	50.7	55.0
*1634-74	65.7	60.0
1647-74	65.2	53.9
1773-74	69.6	73.0
*1829-74	45.3	47.5
*1872-74	85.3	81.9
*1972-74	46.6	57.6
*2089-74	51.3	68.1
2129-74	45.0	33.4
*2131-74	46.3	45.5
*2143-74	52.8	71.5
*2301-74	56.6	32.5
*2367-74	49.9	52.0
*2379-74	77.4	55.0
*2414-74	55.2	57.2
*2432-74	48.3	47.7
*2469-74	52.0	53.0
*2476-74	49.6	53.0
*2477-74	31.2	34.6
2598-74	28.5	34.6
* 184-75	29.2	41.3
* 219-75	61.4	66.5
* 336-75	56.4	57.0
* 439-75	32.2	26.0
*1335-75	45.3	50.4
*1417-75	48.5	42.6

Autopsy No.	Concentration 1	Concentration 2
Age Group 50-59 (Mean - 50.10)		
*1562-74	50.6	51.1
*1694-74	61.6	68.4
1696-74	49.1	50.1
1742-74	51.6	48.0
*1770-74	48.8	56.0
*1898-74	79.6	74.4
1920-74	36.1	35.0
*1945-74	76.9	79.9
*1953-74	55.7	49.9
*2024-74	49.9	52.6
*2031-74	44.3	41.7
*2042-74	67.3	50.3
*2055-74	53.9	50.1
2156-74	35.3	43.7
*2170-74	32.5	32.0
*2278-74	56.0	60.8
*2317-74	25.3	38.9
*2334-74	54.5	86.0
*2354-74	38.6	30.6
2427-74	43.1	51.8
*2443-74	49.2	48.6
2536-74	46.2	52.1
*2578-74	48.1	42.2
*2608-74	56.5	57.2
1-75	36.3	37.4
* 35-75	56.5	50.4
43-75	36.7	34.6
* 62-75	60.5	58.4
* 70-75	58.1	55.0
* 71-75	49.5	69.7
* 63-76	71.6	68.1
Age Group 60+ (Mean - 30.69)		
*2182-74	28.8	32.8

ZINC CONCENTRATIONS IN FAT TISSUE, µg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group 10-19 (Mean 4.04)		
*2137-74	5.6	2.7
*2327-74	34.5	6.2
2521-74	3.7	1.5
*2576-74	7.0	3.2
183-75	2.0	
225-75	0.9	0.9
368-75	1.2	1.1
671-75	0.9	0.3
* 688-75	4.0	5.4
* 886-75	1.0	2.4
*1138-75	6.6	10.8
*1224-75	11.7	0.9
1265-75	4.7	3.7
*1312-75	1.7	2.3
1317-75	2.2	3.5
*1402-75	1.8	2.4
*1505-75	4.7	2.5
Age Group 20-29 (Mean 3.96)		
*1989-74	3.0	4.8
*2190-74	1.2	2.0
*2201-74	4.0	2.6
*2313-74	7.9	16.0
*2376-74	16.0	32.1
2563-74	3.8	2.1
*2577-74	2.0	3.3
*2590-74	1.4	1.1
* 104-75	12.8	9.2
* 117-75	5.6	4.4
* 218-75	5.0	20.8
* 279-75	1.5	0.9
* 286-75	3.5	1.2
* 296-75	1.3	2.3
298-75	1.6	1.1
* 324-75	2.9	2.1
* 335-75	0.9	0.7
* 472-75	2.0	0.8
548-75	2.1	1.0
582-75	1.0	1.6
* 786-75	2.0	1.7
*1272-75	1.5	3.0
Age Group 30-39 (Mean 4.27)		
1706-74	1.5	1.7
1978-74	1.1	0.7

Autopsy No.	Concentration	
	1	2
Age Group 30-39 (Mean–4.27) (Cont'd)		
2059-74	1.2	0.7
*2112-74	2.7	5.4
*2121-74	7.1	4.9
2122-74	8.3	11.2
*2132-74	9.3	10.1
*2140-74	17.8	14.7
*2175-74	1.2	4.1
2184-74	2.5	4.4
2273-74	6.1	2.0
* 60-75	4.5	3.0
257-75	2.3	1.6
* 360-75	1.5	1.6
* 393-75	2.1	2.5
* 425-75	6.8	4.3
514-75	0.8	0.6
* 635-75	7.3	2.0
* 677-75	1.0	1.0
* 733-75	2.2	0.7
* 740-75	4.2	3.8
* 753-75	1.9	1.7
* 794-75	35.4	3.4
* 899-75	3.7	7.0
Age Group 40-49 (Mean–4.50)		
1647-74	<0.5	0.8
* 1972-74	18.5	30.2
* 2089-74	2.9	0.6
2129-74	6.7	2.3
* 2131-74	3.8	5.2
* 2143-74	1.9	3.1
* 2301-74	1.8	4.1
* 2367-74	1.4	0.8
* 2379-74	12.4	14.5
2598-74	4.0	2.8
* 184-75	3.6	18.4
* 219-75	3.8	3.2
* 336-75	3.2	1.6
* 439-75	4.0	5.7
* 1335-75	2.6	2.7
* 1417-75	1.1	1.4
Age Group 50-59 (Mean–3.49)		
* 1694-74	3.3	5.4
* 2024-74	<0.5	1.4

ZINC CONCENTRATIONS IN FAT TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration		Autopsy No.	Concentration	
	1	2		1	2
Age Group 50-59 (Mean 3.49) (Cont'd)					
*2031-74	1.7	1.5			
*2042-74	1.5	1.6			
*2055-74	10.4	3.5			
2156-74	1.7	2.1			
*2170-74	2.2	3.7			
*2317-74	0.6	1.3			
*2334-74	1.7	1.0			
*2354-74	4.7	7.3			
2536-74	2.5	5.8			
*2578-74	5.3	5.4			
*2608-74	1.8	2.0			
1-75	2.0	1.0			
* 35-75	1.7	4.7			
* 62-75	<0.5	0.8			
* 70-75	7.9	3.0			
* 71-75	3.1	5.4			
Age Group 60+ (Mean 13.27)					
*2182-74	15.2	9.9			

APPENDIX I.

AUTOPSY TISSUES
MERCURY RAW DATA

MERCURY CONCENTRATIONS IN MUSCLE TISSUE, μg/gm wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean -0.002)		
1674-74	0.0015	0.0015
1840-74	0.0005	0.0005
1924-74	0.0006	0.0006
*1990-74	0.0024	0.0029
*2137-74	0.0011	0.0011
*2223-74	0.0047	0.0043
*2327-74	0.0009	0.0006
2398-74	0.0017	0.0009
2408-74	0.0014	0.0014
2499-74	0.0006	0.0005
2521-74	0.0029	0.0024
*2576-74	0.0009	0.0008
* 2-75	0.0021	0.0020
183-75	0.0009	0.0005
225-75	0.0017	0.0023
368-75	0.0018	0.0017
671-75	0.0046	0.0036
* 688-75	0.0231	0.0207
* 886-75	0.0006	0.0006
*1138-75	<0.0003	<0.0003
*1224-75	0.0014	0.0014
1265-75	0.0017	0.0014
*1312-75	0.0008	0.0006
1317-75	0.0009	0.0008
*1402-75	0.0017	0.0015
*1505-75	0.0009	0.0011
*1570-75	0.0012	0.0017
*1571-75	0.0014	0.0012
*1679-75	0.0020	0.0011
*1689-75	0.0020	0.0011
1876-75	0.0011	0.0012
1975-75	0.0006	0.0008
*1995-75	<0.0003	<0.0003
Age Group 20-29 (Mean -0.002)		
1564-74	0.0011	0.0008
*1671-74	0.0038	0.0033
1716-74	0.0046	0.0033
*1785-74	0.0012	0.0014
1828-74	0.0018	0.0020
*1836-74	0.0009	0.0008
1861-74	0.0011	0.0006
*1888-74	0.0006	0.0006
*1903-74	0.0009	0.0011
1923-74	0.0011	0.0011
Age Group 20-29 (Mean--0.002) (Cont'd)		
*1936-74	0.0009	0.0009
*1989-74	0.0006	0.0003
*2190-74	0.0047	0.0046
*2201-74	0.0014	0.0014
*2261-74	0.0017	0.0020
*2313-74	0.0018	0.0024
*2376-74	0.0014	0.0017
2419-74	0.0014	0.0014
2431-74	0.0021	0.0026
2563-74	0.0006	0.0008
*2577-74	0.0012	0.0011
*2590-74	0.0008	0.0008
* 104-75	0.0008	0.0008
* 117-75	0.0015	0.0009
* 218-75	0.0017	0.0024
* 279-75	0.0021	0.0041
* 286-75	0.0018	0.0018
* 296-75	0.0006	0.0006
298-75	0.0024	0.0024
* 305-75	0.0207	0.0135
* 324-75	0.0020	0.0014
* 335-75	0.0027	0.0020
* 472-75	0.0015	0.0011
548-75	0.0014	0.0015
582-75	0.0008	0.0008
* 601-75	0.0009	0.0012
* 786-75	0.0018	0.0012
*1272-75	0.0003	0.0005
Age Group 30-39 (Mean–0.002)		
*1682-74	0.0032	0.0032
1706-74	0.0017	0.0017
*1830-74	0.0006	0.0005
*1900-74	0.0003	0.0005
1978-74	<0.0003	<0.0003
2059-74	0.0012	0.0011
*2112-74	0.0018	0.0018
*2121-74	0.0026	0.0029
2122-74	0.0011	0.0006
*2132-74	0.0023	0.0030
*2140-74	0.0011	0.0011
*2175-74	0.0012	0.0008
2184-74	0.0018	0.0012
*2220-74	0.0021	0.0020

MERCURY CONCENTRATIONS IN MUSCLE TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration	
	1	2
Age Group 30-39 (Mean–0.002) (Cont'd)		
*2238-74	0.0008	0.0011
2273-74	0.0015	0.0011
*2401-74	0.0014	0.0014
*2409-74	0.0018	0.0014
* 60-75	0.0015	0.0020
156-75	0.0026	0.0012
257-75	0.0021	0.0023
* 360-75	0.0018	0.0023
* 393-75	0.0064	0.0050
* 425-75	0.0011	0.0006
514-75	0.0014	0.0014
* 635-75	0.0017	0.0017
* 677-75	0.0008	0.0008
* 733-75	0.0014	0.0008
* 740-75	0.0017	0.0011
* 753-75	0.0018	0.0011
* 794-75	0.0021	0.0015
* 899-75	0.0011	0.0012
*1519-75	0.0008	0.0008
Age Group 40-49 (Mean–0.002)		
*1565-74	0.0032	0.0026
*1570-74	0.0011	0.0006
*1575-74	0.0014	0.0012
*1634-74	0.0006	0.0008
1647-74	0.0068	0.0091
1773-74	0.0027	0.0026
*1829-74	0.0009	0.0006
*1872-74	0.0008	0.0008
*1972-74	0.0023	0.0021
*2089-74	0.0026	0.0032
2129-74	0.0074	0.0044
*2131-74	0.0015	0.0012
*2143-74	0.0024	0.0030
*2301-74	0.0021	0.0017
*2367-74	0.0015	0.0014
*2379-74	0.0008	0.0008
*2414-74	0.0029	0.0021
*2432-74	0.0009	0.0012
*2469-74	0.0015	0.0014
*2476-74	0.0044	0.0040
*2477-74	0.0017	0.0015
2598-74	0.0014	0.0014
* 184-75	0.0021	0.0020
* 219-75	0.0033	0.0020
Age Group 40-49 (Mean -0.002) (Cont'd)		
* 336-75	0.0027	0.0032
* 439-75	0.0015	0.0011
*1335-75	0.0006	0.0006
*1417-75	0.0018	0.0018
Age Group 50-59 (Mean–0.002)		
*1562-74	0.0020	0.0017
*1694-74	0.0065	0.0061
1696-74	0.0049	0.0050
1742-74	0.0023	0.0021
*1770-74	0.0024	0.0027
*1898-74	0.0018	0.0018
1920-74	0.0009	0.0006
*1945-74	0.0015	0.0009
*1953-74	0.0012	0.0012
*2024-74	0.0021	0.0014
*2031-74	0.0071	0.0087
*2042-74	0.0018	0.0018
*2055-74	0.0017	0.0011
2156-74	0.0038	0.0018
*2170-74	0.0011	0.0009
*2278-74	0.0030	0.0017
*2317-74	0.0020	0.0017
*2334-74	0.0029	0.0036
*2354-74	0.0015	0.0014
2427-74	0.0014	0.0015
*2443-74	0.0009	0.0006
2536-74	0.0032	0.0029
*2578-74	0.0012	0.0014
*2608-74	0.0023	0.0018
1-75	0.0005	0.0008
* 35-75	0.0047	0.0024
43-75	0.0023	0.0021
* 62-75	0.0040	0.0036
* 70-75	0.0030	0.0024
* 71-75	0.0021	0.0017
* 63-76	0.0015	0.0011
Age Group 60+ (Mean -0.004)		
*2182-74	0.0040	0.0041

MERCURY CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group 10-19 (Mean- 0.084)		
1674-74	0.0546	0.0663
1840-74	0.0884	0.0845
1924-74	<0.0195	<0.0195
*1990-74	0.0910	0.0962
*2137-74	0.1547	0.2054
*2223-74	0.4446	0.4992
*2327-74	0.0650	0.0585
2398-74	0.0650	0.0585
2408-74	0.0949	0.1066
2499-74	0.0585	0.0624
2521-74	0.3055	0.3016
*2576-74	0.0793	0.0702
* 2-75	0.0299	0.0325
183-75	0.0611	0.0572
225-75	0.1079	0.1157
368-75	0.0273	0.0299
671-75	0.0429	0.0494
* 688-75	0.0364	0.0468
* 886-75	0.0442	0.0455
*1138-75	0.0741	0.0819
*1224-75	0.0325	0.0351
1265-75	0.1053	0.1092
*1312-75	<0.0195	<0.0195
1317-75	0.1066	0.1131
*1402-75	0.0299	0.0273
*1505-75	0.0494	0.0442
*1570-75	0.0858	0.0884
*1571-75	0.2041	0.2028
*1679-75	0.0455	0.0624
*1689-75	0.0676	0.0624
1876-75	<0.0195	<0.0195
1975-75	0.0572	0.0507
*1995-75	0.0507	0.0598
Age Group 20-29 (Mean -0.095)		
1564-74	0.0260	0.0260
*1671-74	0.2171	0.1976
1716-74	0.1144	0.1079
*1785-74	0.0689	0.0741
1828-74	0.3536	0.2639
*1836-74	0.0468	0.0442
1861-74	0.1586	0.1443
*1888-74	0.1261	0.1053
*1903-74	0.0858	0.0806
1923-74	0.2340	0.2314
Age Group 20-29 (Mean--0.095) (Cont'd)		
*1936-74	0.0351	0.0429
*1989-74	<0.0195	<0.0195
*2190-74	0.2834	0.3250
*2201-74	0.0299	0.0325
*2261-74	0.1391	0.1391
*2313-74	0.2041	0.2041
*2376-74	0.0845	0.0780
2419-74	0.0637	0.0572
2431-74	0.0455	0.0429
2563-74	0.0299	0.0390
*2577-74	0.0299	0.0377
*2590-74	0.0832	0.0728
* 104-75	0.0754	0.0884
* 117-75	0.0962	0.1027
* 218-75	0.2756	0.2964
* 279-75	0.1053	0.1118
* 286-75	0.1274	0.1196
* 296-75	0.0468	0.0390
298-75	0.0832	0.0936
* 305-75	0.0858	0.0832
* 324-75	0.0273	0.0312
* 335-75	0.0312	0.0234
* 472-75	0.0494	0.0598
548-75	0.0442	0.0416
582-75	0.0845	0.0806
* 601-75	0.0247	0.0247
* 786-75	0.1222	0.1079
*1272-75	<0.0195	<0.0195
Age Group 30-39 (Mean 0.083)		
*1682-74	0.1053	0.1014
1706-74	0.1040	0.0936
*1830-74	0.0858	0.0728
*1900-74	0.0260	0.0260
1978-74	0.0221	<0.0195
2059-74	0.1378	0.1092
*2112-74	0.0546	0.0546
*2121-74	0.0988	0.0871
2122-74	0.0559	0.0559
*2132-74	0.1391	0.1196
*2140-74	0.0559	0.0650
*2175-74	0.1625	0.1885
2184-74	0.1664	0.1859
*2220-74	0.0871	0.0845
*2238-74	0.2262	0.1755

MERCURY CONCENTRATIONS IN LIVER TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group 30-39 (Mean 0.083) (Cont'd)		
2273-74	0.1573	0.1300
*2401-74	0.0987	0.0910
*2409-74	0.1677	0.2249
* 60-75	0.0520	0.0481
156-75	0.0923	0.0858
257-75	0.0325	0.0299
* 360-75	0.0962	0.0728
* 393-75	0.0780	0.0689
* 425-75	0.0403	0.0338
514-75	0.0806	0.0923
* 635-75	0.0741	0.0949
* 677-75	0.0897	0.0832
* 733-75	0.0299	0.0247
* 740-75	0.0234	0.0260
* 753-75	0.0598	0.0650
* 794-75	0.0832	0.0910
* 899-75	0.0390	0.0403
*1519-75	0.0273	0.0273
Age Group 40-49 (Mean 0.084)		
*1565-74	0.0910	0.1170
*1570-74	0.0195	0.0260
*1575-74	0.0299	0.0351
*1634-74	<0.0195	<0.0195
1647-74	0.1820	0.2379
1773-74	0.1846	0.1534
*1829-74	0.0468	0.0416
*1872-74	0.0507	0.0533
*1972-74	0.0403	0.0429
*2089-74	0.0299	0.0299
2129-74	0.4186	0.4381
*2131-74	0.1404	0.1508
*2143-74	0.0260	0.0273
*2301-74	0.1781	0.1300
*2367-74	0.0286	0.0351
*2379-74	0.0702	0.0650
*2414-74	0.1560	0.2093
*2432-74	0.0351	0.0312
*2469-74	0.0494	0.0455
*2476-74	0.2496	0.2405
*2477-74	0.0234	0.0234
2598-74	0.0715	0.0702
* 184-75	<0.0195	<0.0195
* 219-75	0.0468	0.0468
* 336-75	0.0273	0.0351

Autopsy No.	Concentration 1	Concentration 2
Age Group 40-49 (Mean 0.084) (Cont'd)		
* 439-75	0.0338	0.0273
*1335-75	0.1352	0.1196
*1417-75	0.0494	0.0598
Age Group 50-59 (Mean 0.053)		
*1562-74	0.0741	0.0780
*1694-74	0.0585	0.0611
1696-74	0.1027	0.1027
1742-74	0.0390	0.0338
*1770-74	0.0533	0.0598
*1898-74	0.0949	0.0923
1920-74	<0.0195	<0.0195
*1945-74	0.0702	0.0689
*1953-74	0.0234	0.0208
*2024-74	0.0247	0.0273
*2031-74	0.1053	0.1053
*2042-74	0.2912	0.3692
*2055-74	0.0650	0.0520
2156-74	0.0520	0.0494
*2170-74	0.0559	0.0507
*2278-74	0.0221	<0.0195
*2317-74	0.0273	0.0221
*2334-74	0.0130	0.0130
*2354-74	0.0286	0.0273
2427-74	0.0728	0.0806
*2443-74	<0.0195	<0.0195
2536-74	0.0312	0.0351
*2578-74	0.0338	0.0390
*2608-74	0.0286	0.0325
1-75	<0.0195	<0.0195
* 35-75	<0.0195	<0.0195
43-75	0.0884	0.0845
* 62-75	0.1261	0.0975
* 70-75	0.0260	0.0260
* 71-75	0.0273	0.0273
* 63-76	0.0195	0.0234
Age Group 60+ (Mean 0.115)		
*2182-74	0.1274	0.1040

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MERCURY CONCENTRATIONS IN PANCREAS TISSUE, µg/gm wet weight

Age Group 10-19 (Mean 0.010)

Autopsy No.	Concentration 1	Concentration 2
1674-74	0.0099	0.0105
1840-74	0.0189	0.0189
1924-74	0.0045	0.0045
*1990-74	0.0172	0.0189
*2137-74	0.0079	0.0102
*2223-74	0.0378	0.0371
*2327-74	0.0064	0.0051
2398-74	0.0093	0.0094
2408-74	0.0071	0.0069
2499-74	0.0066	0.0064
2521-74	0.0157	0.0186
*2576-74	0.0039	0.0048
* 2-75	0.0116	0.0103
183-75	0.0093	0.0096
225-75	0.0058	0.0066
368-75	0.0057	0.0046
671-75	0.0196	0.0192
* 688-75	0.0051	0.0053
* 886-75	0.0040	0.0030
*1138-75	0.0088	0.0071
*1224-75	0.0072	0.0058
1265-75	0.0252	0.0252
*1312-75	0.0064	0.0060
1317-75	0.0269	0.0217
*1402-75	0.0120	0.0117
*1505-75	0.0072	0.0079
*1570-75	0.0063	0.0073
*1571-75	0.0103	0.0117
*1679-75	0.0057	0.0076
*1689-75	0.0102	0.0111
1876-75	0.0042	0.0045
1975-75	0.0058	0.0049
*1995-75	0.0040	0.0038

Age Group 20-29 (Mean 0.014)

Autopsy No.	Concentration 1	Concentration 2
1564-74	0.0032	0.0030
*1671-74	0.0126	0.0129
1716-74	0.0160	0.0162
*1785-74	0.0061	0.0057
1828-74	0.0477	0.0537
*1836-74	0.0150	0.0139
1861-74	0.0179	0.0150
*1888-74	0.0189	0.0172
*1903-74	0.0147	0.0129
1923-74	0.0297	0.0343

Age Group 20-29 (Mean 0.014) (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
*1936-74	0.0043	0.0033
*1989-74	0.0060	0.0075
*2190-74	0.0456	0.0473
*2201-74	0.0181	0.0181
*2261-74	0.0212	0.0231
*2313-74	0.0145	0.0160
*2376-74	0.0142	0.0109
2419-74	0.0111	0.0108
2431-74	0.0058	0.0060
2563-74	0.0025	0.0030
*2577-74	0.0040	0.0040
*2590-74	0.0081	0.0081
* 104-75	0.0240	0.0225
* 117-75	0.0129	0.0126
* 218-75	0.0196	0.0196
* 279-75	0.0116	0.0108
* 286-75	0.0093	0.0076
* 296-75	0.0038	0.0034
298-75	0.0181	0.0175
* 305-75	0.0181	0.0209
* 324-75	0.0108	0.0114
* 335-75	0.0111	[illegible]
* 472-75	0.0205	[illegible]
548-75	0.0060	0.0069
582-75	0.0142	0.0141
* 601-75	0.0127	[illegible]
* 786-75	0.0166	0.0154
*1272-75	0.0078	0.0071

Age Group 30-39 (Mean 0.009)

Autopsy No.	Concentration 1	Concentration 2
*1682-74	0.0145	0.0130
1706-74	0.0234	0.0234
*1830-74	0.0175	0.0212
*1900-74	0.0071	0.0086
1978-74	0.0043	0.0039
2059-74	0.0216	0.0171
*2112-74	0.0042	0.0042
*2121-74	0.0071	0.0084
2122-74	0.0027	0.0027
*2132-74	0.0023	0.0023
*2140-74	0.0090	0.0103
*2175-74	0.0072	0.0069
2184-74	0.0081	0.0086
*2220-74	0.0150	0.0169
*2238-74	0.0072	0.0073
2273-74	0.0130	0.0138

MERCURY CONCENTRATIONS IN PANCREAS TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group 30-39 (Mean 0.009) (Cont'd)		
*2401-74	0.0042	0.0054
*2409-74	0.0091	0.0093
* 60-75	0.0060	0.0061
156-75	0.0079	0.0073
257-75	<0.0015	0.0015
* 360-75	0.0120	0.0112
* 393-75	0.0135	0.0130
* 425-75	0.0079	0.0096
514-75	0.0099	0.0096
* 635-75	0.0086	0.0078
* 677-75	0.0204	0.0202
* 733-75	0.0033	0.0025
* 740-75	0.0040	0.0045
* 753-75	0.0075	0.0084
* 794-75	0.0154	0.0162
* 899-75	0.0033	0.0038
*1519-75	0.0043	0.0046
Age Group 40-49 (Mean 0.011)		
*1565-74	0.0294	0.0234
*1570-74	0.0042	0.0046
*1575-74	0.0042	0.0038
*1634-74	0.0033	0.0033
1647-74	0.0321	0.0333
1773-74	0.0470	0.0492
*1829-74	0.0094	0.0090
*1872-74	0.0064	0.0060
*1972-74	0.0075	0.0066
*2089-74	0.0078	0.0086
2129-74	0.0223	0.0244
*2131-74	0.0132	0.0144
*2143-74	0.0020	0.0024
*2301-74	0.0123	0.0108
*2367-74	0.0105	0.0084
*2379-74	0.0073	0.0084
*2414-74	0.0244	0.0202
*2432-74	0.0096	0.0094
*2469-74	0.0076	0.0087
*2476-74	0.0157	0.0147
*2477-74	0.0048	0.0042
2598-74	0.0048	0.0057
* 184-75	<0.0015	0.0016
* 219-75	0.0046	0.0048
* 336-75	0.0045	0.0046
* 439-75	0.0040	0.0036
Age Group 40-49 (Mean 0.011) (Cont'd)		
*1335-75	0.0048	0.0061
*1417-75	0.0151	0.0116
Age Group 50-59 (Mean 0.010)		
*1562-74	0.0101	0.0119
*1694-74	0.0145	0.0168
1969-74	0.0154	0.0150
1742-74	0.0048	0.0049
*1770-74	0.0136	0.0138
*1898-74	0.0096	0.0099
1920-74	0.0090	0.0088
*1945-74	0.0071	0.0071
*1953-74	0.0058	0.0060
*2024-74	0.0042	0.0054
*2031-74	0.0615	0.0667
*2042-74	0.0135	0.0138
*2055-74	0.0045	0.0034
2156-74	0.0048	0.0051
*2170-74	0.0093	0.0093
*2278-74	0.0032	0.0039
*2317-74	0.0091	0.0079
*2334-74	0.0071	0.0069
*2354-74	0.0025	0.0030
2427-74	0.0162	0.0149
*2443-74	0.0039	0.0043
2536-74	0.0034	0.0045
*2578-74	0.0036	0.0040
*2608-74	0.0086	0.0091
1-75	0.0068	0.0058
* 35-75	0.0060	0.0064
43-75	0.0120	0.0093
* 62-75	0.0134	0.0120
* 70-75	0.0060	0.0060
* 71-75	0.0090	0.0090
* 63-76	0.0076	0.0072
Age Group 60+ (Mean 0.007)		
*2182-74	0.0079	0.0066

MERCURY CONCENTRATIONS IN KIDNEY TISSUE, μg/gm wet weight

Autopsy No.	Concentration	
	1	2
Age Group 10-19 (Mean 0.462)		
1674-74	0.1353	0.1418
1840-74	0.7368	0.7368
1924-74	<0.1298	<0.1298
*1990-74	0.6438	0.6504
*2137-74	0.4515	0.5004
*2223-74	5.2144	5.9136
*2327-74	0.1858	0.1907
2398-74	0.6960	0.7237
2408-74	0.6683	0.7433
2499-74	0.2249	0.2445
2521-74	2.7091	2.5575
*2576-74	0.4173	0.4352
* 2-75	0.3602	0.3863
183-75	0.4059	0.4531
225-75	0.8655	0.7759
368-75	<0.1288	<0.1288
671-75	0.5200	0.4711
* 688-75	0.2673	0.2363
* 886-75	0.2755	0.2559
*1138-75	<0.1288	<0.1288
*1224-75	0.5167	0.5754
1265-75	0.6178	0.6341
*1312-75	0.1581	0.1288
1317-75	0.9584	0.9193
*1402-75	0.4091	0.4075
*1505-75	0.3130	0.3293
*1570-75	0.2885	0.3227
*1571-75	0.2315	0.2347
*1679-75	0.2543	0.2119
*1689-75	<0.1288	<0.1288
1876-75	0.1809	0.1989
1975-75	0.1956	0.2298
*1995-75	0.2315	0.2184
Age Group 20-29 (Mean 0.719)		
1564-74	0.1956	0.1826
*1671-74	0.6764	0.6797
1716-74	2.4743	2.4743
*1785-74	0.3782	0.3961
1828-74	0.7498	0.7531
*1836-74	0.4271	0.4678
1861-74	0.6324	0.6292
*1888-74	0.3782	0.3374
*1903-74	0.9698	1.0204
1923-74	2.5493	2.6536
Age Group 20-29 (Mean–0.719) (Cont'd)		
*1936-74	0.3537	0.4140
*1989-74	0.1337	0.1516
*2190-74	5.6251	5.4996
*2201-74	0.5314	0.5705
*2261-74	1.6056	1.6561
*2313-74	0.3994	0.4124
*2376-74	0.3553	0.3977
2419-74	0.7971	1.0367
2431-74	<0.1288	<0.1288
2563-74	0.1956	0.2021
*2577-74	0.1728	0.1565
*2590-74	0.4971	0.4205
* 104-75	0.6683	0.6618
* 117-75	0.4662	0.3896
* 218-75	1.6316	1.6642
* 279-75	0.9568	0.7873
* 286-75	1.7490	1.9902
* 296-75	0.1744	0.1728
298-75	0.6341	0.6373
* 305-75	1.0090	0.9666
* 324-75	0.4531	0.4173
* 335-75	0.8199	0.7498
* 472-75	1.2111	1.1491
548-75	0.1434	0.1402
582-75	1.3301	1.1540
* 601-75	0.7074	0.6748
* 786-75	1.1377	1.0693
*1272-75	0.1923	0.2021
Age Group 30-39 (Mean 0.634)		
*1682-74	0.2526	0.2494
1706-74	1.2192	1.0611
*1830-74	0.5461	0.5395
*1900-74	0.1777	0.1369
1978-74	0.2054	0.1923
2059-74	0.9519	0.9731
*2112-74	0.2429	0.2412
*2121-74	<0.1288	<0.1288
2122-74	0.1940	0.2086
*2132-74	0.2608	0.2396
*2140-74	0.3912	0.4336
*2175-74	0.3782	0.3667
2184-74	0.5216	0.5183
*2220-74	1.9234	1.5159
*2238-74	1.5338	1.4523

MERCURY CONCENTRATIONS IN KIDNEY TISSUE, μg/gm wet weight (Cont'd)

Autopsy No.	Concentration	
	1	2
Age Group 30-39 (Mean 0.634) (Cont'd)		
2273-74	1.4735	1.8533
*2401-74	1.8142	1.7767
*2409-74	0.8020	0.8020
* 60-75	0.1597	0.2347
156-75	5.6969	6.1206
257-75	0.2543	0.2804
* 360-75	0.5721	0.6112
* 393-75	6.0082	6.2380
* 425-75	0.2901	0.3146
514-75	0.7286	0.7319
* 635-75	0.3488	0.3521
* 677-75	0.5379	0.4662
* 733-75	<0.1288	0.1288
* 740-75	<0.1288	<0.1288
* 753-75	0.2412	0.2787
* 794-75	0.4971	0.4548
* 899-75	0.2755	0.2967
*1519-75	0.2005	0.2119
Age Group 40-49 (Mean 0.626)		
*1565-74	1.8435	2.0831
*1570-74	0.3369	0.3276
*1575-74	<0.1288	<0.1288
*1634-74	0.1467	0.1630
1647-74	1.7311	1.8289
1773-74	5.3448	5.7588
*1829-74	<0.1288	<0.1288
*1872-74	<0.1288	<0.1288
*1972-74	1.5892	1.5697
*2089-74	0.5134	0.4678
2129-74	2.7710	2.8607
*2131-74	0.7058	0.6879
*2143-74	<0.1288	<0.1288
*2301-74	0.4042	0.4108
*2367-74	0.1516	0.1581
*2379-74	0.2135	0.2412
*2414-74	0.9144	0.9389
*2432-74	0.6308	0.5819
*2469-74	0.5493	0.5526
*2476-74	1.7816	1.7490
*2477-74	<0.1288	<0.1288
2598-74	2.9764	2.8215
* 184-75	<0.1288	<0.1288
* 219-75	0.1402	0.1565
* 336-75	0.3847	0.3651
Age Group 40-49 (Mean 0.626) (Cont'd)		
* 439-75	<0.1288	<0.1288
*1335-75	<0.1288	<0.1288
*1417-75	0.4450	0.4613
Age Group 50-59 (Mean -0.540)		
*1562-74	0.2347	0.2575
*1694-74	1.8908	2.0603
1696-74	0.3260	0.3847
1742-74	0.2021	0.2412
*1770-74	0.6259	0.5330
*1898-74	0.2347	0.2641
1920-74	0.2282	0.2363
*1945-74	0.4271	0.4450
*1953-74	0.3276	0.3504
*2024-74	0.4809	0.4564
*2031-74	0.6667	0.6813
*2042-74	0.5281	0.5037
*2055-74	0.3146	0.3293
2156-74	1.4719	1.5974
*2170-74	0.1858	0.1483
*2278-74	2.1190	2.5379
*2317-74	0.5346	0.5509
*2334-74	<0.1288	<0.1288
*2354-74	0.1516	0.1467
2427-74	1.1084	1.1214
*2443-74	0.1875	0.1728
2536-74	0.6047	0.6096
*2578-74	0.3619	0.3896
*2608-74	0.2918	0.2869
1-75	0.7547	0.7938
* 35-75	0.2559	0.2836
43-75	0.5461	0.5102
* 62-75	1.7262	1.5664
* 70-75	0.3374	0.3309
* 71-75	0.5526	0.4760
* 63-76	0.9161	0.8443
Age Group 60+ (Mean 0.203)		
*2182-74	0.2152	0.1907

MERCURY CONCENTRATIONS IN FAT TISSUE, μg/gm wet weight

Autopsy No.	Concentration 1	Concentration 2
Age Group 10-19 (Mean 0.0067)		
1674-74	0.0061	0.0037
1840-74	0.0074	0.0128
1924-74	0.0037	0.0040
*1990-74	0.0088	0.0086
*2137-74	0.0035	0.0033
*2223-74	0.0223	0.0272
*2327-74	0.0047	0.0039
2398-74	0.0061	0.0028
2408-74	0.0057	0.0045
2499-74	0.0100	0.0098
2521-74	0.0065	0.0056
*2576-74	0.0051	0.0068
* 2-75	0.0082	0.0072
183-75	0.0096	0.0098
225-75	0.0015	0.0052
368-75	0.0253	0.0141
671-75	0.0084	0.0070
* 688-75	0.0070	0.0065
* 886-75	<0.0029	<0.0029
*1138-75	0.0096	0.0114
*1224-75	0.0092	0.0114
1265-75	0.0043	0.0069
*1312-75	<0.0029	<0.0029
1317-75	0.0080	0.0088
*1402-75	0.0045	0.0040
*1505-75	0.0084	0.0142
*1570-75	0.0044	0.0035
*1679-75	0.0045	0.0047
*1689-75	<0.0029	<0.0029
1876-75	<0.0029	<0.0029
1975-75	<0.0029	<0.0029
*1995-75	0.0041	0.0040
Age Group 20-29 (Mean 0.0057)		
1564-74	0.0049	0.0044
*1671-74	<0.0029	0.0029
1716-74	0.0052	0.0076
*1785-74	0.0036	<0.0029
1828-74	0.0085	0.0066
*1836-74	<0.0029	0.0029
1861-74	0.0085	0.0108
*1888-74	0.0114	<0.0029
*1903-74	0.0051	0.0056
1923-74	0.0180	0.0184
*1936-74	<0.0029	<0.0029
Age Group 20-29 (Mean–0.0057) (Cont'd)		
*1989-74	0.0029	0.0036
*2190-74	0.0031	<0.0029
*2201-74	0.0097	0.0098
*2261-74	<0.0029	<0.0029
*2313-74	0.0093	0.0122
*2376-74	<0.0029	<0.0029
2419-74	<0.0029	<0.0029
2431-74	0.0080	0.0066
2563-74	0.0045	0.0048
*2577-74	0.0029	<0.0029
*2590-74	<0.0029	<0.0029
* 104-75	0.0051	0.0080
* 117-75	0.0032	<0.0029
* 218-75	0.0196	0.0173
* 279-75	0.0102	0.0092
* 286-75	0.0089	0.0070
* 296-75	0.0043	0.0048
298-75	0.0086	0.0052
* 305-75	0.0088	0.0060
* 324-75	0.0066	0.0080
* 335-75	<0.0029	<0.0029
* 472-75	0.0047	0.0037
548-75	0.0081	0.0044
582-75	0.0064	0.0066
* 601-75	0.0092	0.0043
* 786-75	0.0068	0.0049
*1272-75	<0.0029	<0.0029
Age Group 30-39 (Mean -0.0040)		
*1682-74	0.0074	0.0086
1706-74	0.0048	0.0039
*1830-74	0.0061	0.0064
*1900-74	0.0029	<0.0029
1978-74	<0.0029	<0.0029
2059-74	0.0033	0.0040
*2112-74	0.0084	0.0078
*2121-74	0.0047	0.0029
2122-74	0.0068	0.0078
*2132-74	0.0060	0.0052
*2140-74	0.0078	0.0077
*2175-74	<0.0029	<0.0029
2184-74	0.0048	0.0032
*2220-74	<0.0029	<0.0029
*2238-74	<0.0029	<0.0029
2273-74	<0.0029	<0.0029

MERCURY CONCENTRATIONS IN FAT TISSUE, µg/gm wet weight (Cont'd)

Autopsy No.	Concentration 1	Concentration 2
Age Group 30-39 (Mean 0.0040) (Cont'd)		
*2401-74	<0.0029	<0.0029
*2409-74	0.0047	0.0052
* 60-75	0.0056	0.0045
156-75	0.0059	0.0053
257-75	0.0065	0.0063
* 360-75	0.0044	<0.0029
* 393-75	0.0029	0.0029
* 425-75	0.0065	0.0080
514-75	<0.0029	<0.0029
* 635-75	<0.0029	<0.0029
* 677-75	<0.0029	<0.0029
* 733-75	<0.0029	<0.0029
* 740-75	0.0069	0.0069
* 753-75	0.0048	0.0055
* 794-75	0.0036	<0.0029
* 899-75	0.0043	0.0055
*1519-75	<0.0029	<0.0029
Age Group 40-49 (Mean 0.0062)		
*1565-74	0.0072	0.0094
*1570-74	0.0051	0.0054
*1575-74	0.0063	0.0041
*1634-74	0.0079	0.0041
1647-74	0.0053	0.0060
1773-74	0.0112	0.0126
*1829-74	0.0057	0.0055
*1872-74	0.0038	0.0057
*1972-74	<0.0029	<0.0029
*2089-74	<0.0029	0.0033
2129-74	0.0036	0.0044
*2131-74	0.0049	0.0056
*2143-74	<0.0029	<0.0029
*2301-74	0.0080	0.0057
*2367-74	0.0068	0.0053
*2379-74	0.0081	0.0125
*2414-74	0.0031	<0.0029
*2432-74	0.0146	0.0079
*2469-74	0.0040	0.0049
*2476-74	0.0172	0.0218
*2477-74	0.0057	0.0077
2598-74	0.0116	0.0097
* 184-75	0.0036	<0.0029
* 219-75	0.0045	0.0055
* 336-75	0.0098	0.0109
* 439-75	0.0072	0.0056
Age Group 40-49 (Mean 0.0062) (Cont'd)		
*1335-75	0.0064	0.0098
*1417-75	0.0031	<0.0029
Age Group 50-59 (Mean–0.0054)		
*1562-74	<0.0029	<0.0029
*1694-74	0.0053	0.0052
1696-74	0.0093	0.0063
1742-74	0.0066	0.0066
*1770-74	0.0093	0.0102
*1898-74	0.0064	0.0053
1920-74	0.0059	0.0037
*1945-74	0.0029	0.0051
*1953-74	0.0105	0.0112
*2024-74	<0.0029	<0.0029
*2031-74	0.0097	0.0082
*2042-74	0.0068	0.0056
*2055-74	<0.0029	<0.0029
2156-74	0.0069	0.0052
*2170-74	0.0076	0.0061
*2278-74	0.0134	0.0120
*2317-74	0.0049	<0.0029
*2334-74	0.0048	0.0056
*2354-74	0.0066	0.0052
2427-74	0.0033	0.0034
*2443-74	0.0077	0.0033
2536-74	0.0048	0.0047
*2578-74	0.0029	<0.0029
*2608-74	0.0060	0.0053
1-75	0.0051	0.0040
* 35-75	0.0055	0.0044
43-75	0.0080	0.0060
* 62-75	0.0070	0.0070
* 70-75	0.0043	0.0037
* 71-75	0.0031	0.0032
* 63-76	<0.0029	<0.0029
Age Group 60+ (Mean–0.0109)		
*2182-74	0.0110	0.0106

APPENDIX J.

LIVING SUBJECTS
CD RAW DATA

CADMIUM CONCENTRATIONS IN FECES, µg/gm wet weight

Participant ID	Concentration	
	1	2
Age Group 0-9 (Mean 0.140)		
16	0.078	0.081
18	0.303	0.200
25	0.086	0.089
32	0.109	0.239
36	0.074	0.122
111	0.175	0.130
112	0.176	0.176
151	0.102	0.106
152	0.127	0.197
156	0.228	0.114
159	0.111	0.119
173	0.128	0.231
174	0.151	0.053
175	0.077	0.173
190	0.142	0.142
Age Group 10-19 (Mean 0.139)		
17	0.385	0.266
40	0.081	0.114
77	0.105	0.081
154	0.106	0.106
164	0.179	0.107
187	0.127	0.119
188	0.244	0.082
192	0.075	0.070
Age Group 20-29 (Mean 0.109)		
*1	0.074	0.140
*14	0.107	0.109
20	0.037	0.108
21	0.185	0.171
26	0.156	0.125
30	0.187	0.029
†38	0.065	0.037
†44	0.135	0.135
47	0.033	0.041
†48	0.045	0.040
†54	0.108	0.138
56	0.052	0.141
57	0.064	0.064
*59	0.274	0.234
155	0.180	0.180
199	0.050	0.059

Participant ID	Concentration	
	1	2
Age Group 30-39 (Mean -0.103)		
22	0.115	0.154
33	0.126	0.045
80	0.127	0.024
158	0.280	0.189
166	0.063	0.065
*182	0.078	0.070
*189	0.062	0.062
Age Group 40-49 (Mean 0.115)		
† 3	0.109	0.150
* 46	0.082	0.278
51	0.016	0.149
†150	–0.000	0.232
†153	0.014	0.086
†170	0.116	0.098
176	0.143	0.133
*180	0.111	0.111
†183	0.086	0.112
*184	0.058	0.370
†185	0.089	0.114
*186	0.200	0.073
191	0.150	0.017
†193	0.109	0.122
†194	0.106	0.095
200	0.118	0.134
Age Group 50+ (Mean--0.112)		
* 4	0.156	0.127
5	0.041	0.062
† 8	0.174	0.073
* 10	0.135	0.157
* 13	0.074	0.044
* 15	0.123	0.056
29	0.082	0.103
37	0.045	0.098
† 39	0.053	0.082
†157	0.075	0.193
161	0.093	0.113
*162	0.189	0.114
163	0.124	0.149
167	0.065	0.070
†168	0.161	0.165
†171	0.231	0.170

***denotes cigarette smoker.**
†denotes former cigarette smoker.

CADMIUM CONCENTRATIONS IN FECES, µg/gm wet weight (Cont'd)

Participant ID	Concentration 1	Concentration 2	Participant ID	Concentration 1	Concentration 2
Age Group 50+ (Mean 0.112) (Cont'd)					
177	0.213	0.077			
178	0.124	0.097			
179	0.088	0.080			
† 181	0.088	0.085			
195	0.170	0.231			
† 196	0.085	0.037			
† 197	0.123	0.093			
† 198	0.102	0.066			

CADMIUM CONCENTRATIONS IN URINE, µg/ℓ

Participant ID	Concentration 1	Concentration 2
Age Group 0-9 (Mean–0.415)		
16	0.150	0.130
18	0.670	0.530
25	0.580	0.520
32	0.400	0.650
36	0.360	0.220
111	0.820	0.500
112	0.880	0.460
151	0.630	1.430
152	0.630	0.160
156	0.620	0.070
159	0.130	0.260
173	0.160	0.160
174	0.070	0.520
175	0.170	0.210
190	0.560	0.360
Age Group 10-19 (Mean–0.334)		
17	0.530	0.360
40	0.360	0.670
77	0.070	0.210
154	0.180	0.180
164	0.480	0.580
187	0.210	0.320
188	0.480	0.240
192	0.400	0.190
Age Group 20-29 (Mean -0.422)		
* 1	0.710	0.660
* 14	0.150	0.070
20	0.250	0.270
21	0.680	0.550
26.	0.350	0.280
30	0.230	0.070
† 38	0.230	0.350
† 44	0.290	0.410
47	0.230	0.830
† 48	0.370	0.340
† 54	0.530	0.930
56	0.950	0.430
57	0.900	0.680
* 59	0.240	0.490
155	0.070	0.290
199	0.480	0.720

Participant ID	Concentration 1	Concentration 2
Age Group 30-39 (Mean 0.496)		
22	1.090	0.390
33	0.580	0.760
80	0.240	0.450
158	0.220	0.200
166	0.370	0.400
* 182	1.170	0.960
* 189	0.300	0.180
Age Group 40-49 (Mean 0.797)		
† 3	0.610	1.040
* 46	0.780	0.480
51	0.310	0.620
† 150	0.680	0.680
† 153	1.540	1.010
† 170	1.510	0.470
176	1.070	0.650
* 180	0.560	0.560
† 183	1.600	0.900
* 184	1.430	1.110
† 185	0.370	0.710
* 186	0.830	1.200
191	0.610	0.320
† 193	1.720	1.110
† 194	0.070	0.660
200	0.730	0.460
Age Group 50+ (Mean–0.704)		
* 4	1.770	1.100
5	0.500	0.520
† 8	1.070	1.420
* 10	2.060	2.210
* 13	1.150	1.100
* 15	0.190	0.620
29	0.530	0.280
37	0.620	0.350
† 39	0.510	0.880
†157	0.630	0.400
161	0.330	1.010
*162	0.530	0.550
163	0.310	0.300
167	0.550	0.290
†168	1.230	1.430
†171		

***denotes cigarette smoker.**

†denotes former cigarette smoker.

CADMIUM CONCENTRATIONS IN URINE, μg/ℓ (Cont'd)

Participant ID	Concentration 1	Concentration 2	Participant ID	Concentration 1	Concentration 2
Age Group 50+ (Mean–0.704) (Cont'd)					
†171	0.950	1.030			
177	0.240	0.410			
178	0.660	0.680			
179	0.530	0.440			
†181	0.300	0.820			
195	0.200	1.180			
†196	0.740	0.720			
†197	0.260	0.300			
†198	0.870	1.240			

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